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Conceptualising pathological self-monitoring of physical activity

By

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A thesis submitted in partial fulfilment of the requirements of the degree of Doctor of Philosophy in Engineering

WMG, University of Warwick

March 2020

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Acknowledgements

Many thanks to my supervisors, colleagues, family and friends who have supported me throughout the process of completing this thesis. I would also like to extend my gratitude to the people who contributed data that made the research presented within this thesis possible.

Declaration and inclusion of material from a prior thesis

The author declares that the work contained within this thesis is his own work, and has not previously been submitted for examination at any other university or institution.

Aspects of the work presented in this thesis have been published in academic journals detailed below:

- Study 2: McCaig, D., Bhatia, S., Elliott, M.T., Walasek, L. & Meyer, C. (2018). Text-mining as a methodology to assess eating disorder-relevant factors: Comparing mentions of fitness tracking technology across online communities. *International Journal of Eating Disorders*, 51, pp. 647-655. DOI: 10.1002/eat.22882
- Study 3: McCaig, D., Elliott, M.T., Prnjak, K., Walasek, L. & Meyer, C. (2019). Engagement with *MyFitnessPal* in eating disorders: Qualitative insights from online forums. *International Journal of Eating Disorders*, 53, pp. 404-411. DOI: 10.1002/eat.23205
- Study 6: McCaig, D., Elliott, M.T., Siew, C.S.Q., Walasek, L. & Meyer, C. (2019). Profiling commenters on mental health-related online forums: A methodological example focusing on eating disorder-related commenters. *JMIR Mental Health*, 6(4), e12555. DOI:10.2196/12555

With the exception of the author's doctoral supervisors (Elliott, M.T., Walasek, L. and Meyer, C.), the individuals detailed below have provided feedback on studies included in this thesis.

- Bhatia, S.: Study 2
- Pegler, A.: Study 1
- Plateau, C.: Studies 4 and 5
- Prnjak, K.: Study 3
- Siew, C.S.Q.: Study 6

Glossary

List of abbreviations

BCQ	Body Checking Questionnaire
CBT-E	Cognitive Behavioural Therapy-Enhanced
CET	Compulsive Exercise Test
DSM	Diagnostic and Statistical Manual of Mental Disorders
EDE-Q	Eating Disorder Examination Questionnaire
ICD	International Classification of Diseases
IPAQ	International Physical Activity Questionnaire
MBCQ	Male-Specific Body Checking Questionnaire
RDoC	Research Domain Criteria

List of terms

app	An application on an electronic device (e.g., smartphone)
diet tracker	A device or app aiding the self-monitoring of diet
fitness tracker	A device or app aiding the self-monitoring of physical activity
Reddit	An online discussion platform
subreddit	An online forum on *Reddit*
thread	A series of online comments made in response to one post

Abstract

Background: Technologies that facilitate monitoring one's physical activity are potentially detrimental for people with high levels of eating psychopathology and compulsive exercise. Investigations in this area are complicated by the diverse functionality these technologies offer, and the varied ways in which a person can engage with a device or application. Furthermore, physical activity can be monitored without these technologies. *Objective*: This thesis aimed to develop a more comprehensive conceptualisation of physical activity self-monitoring in relation to eating psychopathology and compulsive exercise. *Methodology*: The research programme used diverse data sources (survey, semi-structured interviews, online forums) and analytical methods – both qualitative (thematic analysis) and quantitative (word-counts, network analysis). First, analyses of eating disorder forums investigated interest in, and engagement with physical activity self-monitoring-related technologies. Forms and focuses of physical activity self-monitoring were then captured through a survey, followed by interviews with people indicating high levels of compulsive exercise to investigate the nature of physical activity self-monitoring in greater depth. Last, further thematic analyses of eating disorder forums – conducted separately for people with high or low focuses on recovery – evaluated the comprehensiveness of the previous findings. *Findings*: The overall findings were grouped into five themes: *Engagement and accuracy* (the nature of physical activity self-monitoring); *Comparisons* (how and to what one's physical activity is compared); *Monitoring non-physical activity focuses* (e.g., how monitoring one's physique relates to physical activity); *Cognitions, affect and behaviours* (how specific psychological factors potentially relate to physical activity self-monitoring); and *Interpersonal factors* (how physical activity self-monitoring is enacted in relation to others). *Implications*: Future research is outlined, with the development of a measurement instrument being particularly emphasised. More immediately, the findings can assist clinicians and technology manufacturers in identifying aspects of physical activity self-monitoring that are potentially detrimental to people with high levels of eating psychopathology and compulsive exercise.

1. Introduction

1.1. Overview of thesis

Commercially available devices and applications (i.e., 'apps') that facilitate the monitoring of one's physical activity have become widely owned and used (Liu, 2019). While these technologies are often advocated as a tool to encourage 'healthy' behaviour change, there is growing concern about how they are used by people with high levels of eating psychopathology (e.g., Fairburn & Rothwell, 2015). Separately, pathological physical activity (i.e., 'compulsive exercise'; e.g., Adkins & Keel, 2005) and self-monitoring (e.g., 'body checking'; e.g., Reas, White, & Grilo, 2006) are commonly observed in people with eating disorders. As self-monitoring is suggested to play an influential role in self-regulation (Carver & Scheier, 1982), use of technologies that facilitate the self-monitoring of physical activity could therefore be related to eating disorder symptomatology.

Research investigating the relationship between eating psychopathology, and the use of devices and apps for self-monitoring physical activity is in its infancy (e.g., Hefner et al., 2016; Levinson, Fewell, & Brosof, 2017; Simpson & Mazzeo, 2017). As such, the way in which these early studies assess the use of these technologies will likely influence subsequent research. To date, such assessment has predominantly comprised quantitative self-report items, and has typically asked about use dichotomously (i.e., user vs. non-user; e.g., Simpson & Mazzeo, 2017), or about the frequency of use (e.g., Plateau, Bone, Lanning, & Meyer, 2018). However, other patterns of engagement with these devices and apps (e.g., consistency of use) must be considered to develop a clearer understanding of the relationship with eating psychopathology. Furthermore, by narrowly focusing on technology-enhanced self-monitoring, the influence of other ways in which someone might monitor their physical activity (e.g., recording in a notebook) remains unaddressed. Consequently, the robust assessment of relationships between eating psychopathology and physical activity self-monitoring requires a much broader consideration of how the monitoring is performed, rather than simply the use or non-use of specific devices and apps.

Together with the background provided, the studies reported in this thesis aimed to generate substantive validity evidence for the construct of physical activity self-monitoring in relation to eating psychopathology and compulsive exercise. The current chapter provides an outline of the construct validation process (subsection 1.2.1.), followed by a discussion of the value of precise and theoretically defined constructs (subsection 1.2.2.), and the importance of ensuring that the content of measurement tools aligns with one's definition of the construct (subsection 1.2.3.). After an overview of pathological eating and exercise constructs (section 1.3.), one such construct, body checking (i.e., monitoring one's body), is refined using behaviour change theory (section 2.1.), and the content of common body checking self-report scales is critically reviewed (Study 1; section 2.2.). A consideration of self-monitoring diet and physical activity in the context of eating disorders is then presented (section 3.1.), followed by a summary of the thesis' aims (section 3.2.) and its methodology (section 3.3). The subsequent six chapters outline the core studies comprising the thesis. First presented are quantitative analyses (Study 2; chapter 4) and qualitative analyses (Study 3; chapter 5) of comments mentioning physical activity self-monitoring technology that were made on online eating disorder forums. Next, a large-scale survey (Study 4; chapter 6) and interviews with compulsive exercisers (Study 5; chapter 7) are reported that developed a broader conceptualisation of physical activity self-monitoring in relation to eating psychopathology and compulsive exercise. Following a study that profiled online forum commenters (Study 6; chapter 8), qualitative analyses of comments concerning the broader physical activity self-monitoring construct are then presented separately for commenters who contributed to low and/or high recovery-focused eating disorder forums (Study 7; chapter 9). Finally, an overall discussion of the findings of this thesis is presented (chapter 10).

1.2. Construct validity

"… construct validity is the foundation of clinical utility"

– Clark and Watson (2019, p. 2)

Construct validity is a fundamental, yet contentious issue (e.g., Hughes, 2018). Building on influential works from the twentieth century (e.g., Cronbach & Meehl, 1955; Messick, 1989), the *Standards for Educational and Psychological Testing* (AERA, APA & NCME, 2014, p. 11) defined construct validity as "… the degree to which evidence and theory support the interpretations of test scores for proposed uses of tests". While contrasting definitions have been proposed (e.g., validity being an attribute of a test, not of a test result's interpretation; e.g., Borsboom, Mellenbergh, & van Heerden, 2004), this thesis will adhere to the definition of construct validity outlined in the *Standards for Educational and Psychological Testing*, due to its status as American Psychological Association policy.

Despite the ongoing debate about the nature of construct validity, its importance is without question. In the absence of any degree of construct validity, it is simply not possible to appraise the quality of findings from psychological research, nor the clinical decisions that might be based on this research (e.g., Clark & Watson, 2019; Flake, Pek, & Hehman, 2017). However, it is suggested that researchers often pay insufficient attention to construct validity, which is perhaps unsurprising given its complex and contested nature (Clark & Watson, 2019). Consequently, there is reason to believe that a greater consideration of construct validity would result in an improvement in the quality of psychological research findings.

1.2.1. Construct validation process

In contrast to measuring more observable variables (e.g., distance, volume), psychological constructs (e.g., self-concept, depression) must be validated, which involves the generation of several types of validity evidence through a continual and iterative process (e.g., Clark & Watson, 2019; Flake et al., 2017; Maul, 2017; Strauss & Smith, 2009). The construct validation process is conceptualised as having three distinct components, which were first outlined by Loevinger (1957) and remain highly influential. First, the *substantive component* concerns the conceptualisation of a construct, and identification of content that is necessary for its measurement. Second, the *structural component* involves the assessment of the psychometric properties of the construct's measurement (e.g., factor structure, reliability). Third,

the *external component* comprises investigation into how the construct of interest relates to similar and different constructs (i.e., convergent and discriminant validity).

While all components (i.e., "phases"; Flake et al., 2017) of the validation process are crucial, substantive validity evidence is typically neglected in comparison to structural and external validity evidence (Dixon & Johnston, 2019; Flake et al., 2017; MacKenzie, Podsakoff, & Podsakoff, 2011). Due to these phases representing a sequential process (e.g., Flake et al., 2017), neglect of substantive validity evidence compromises the evidence arising from the later phases (Clark & Watson, 2019). In the absence of substantive validity evidence, even a structurally reliable measure could lead to misinterpreted findings, as its score might have no relation to the intended target construct (Dixon & Johnston, 2019). This is particularly concerning as favourable structural validity evidence for a measure can be obtained even when the measure is deliberately designed to be uninterpretable (Maul, 2017). Specifically, Maul reported favourable statistical evidence (e.g., high reliability, statistically significant correlations with established psychological constructs) for three sets of self-report item-stems that either included nonsense terms, comprised placeholder Latin text, or contained no text at all. Consequently, in the absence of substantive validity evidence, there is little justification to assign any importance to structural or external validity evidence.

For the reasons detailed above, the research comprising this thesis focused primarily on the substantive phase of the construct validation process. As such, two related aspects of substantive validity require further consideration: construct conceptualisation (subsection 1.2.2.), and content validity (subsection 1.2.3.).

1.2.2. Construct conceptualisation

For a construct to be accurately measured, it must first be clearly and precisely conceptualised and defined (Clark & Watson, 1995, 2019; Furr, 2011; McGrath, 2005). However, in many psychological studies, definitions of constructs are “vague at best and incoherent or entirely absent at worst” (Maul, 2017, p. 61).

Incorporating theory into the construct validation process is crucial for precise conceptualisation and definition (AERA, APA & NCME, 2014; Cronbach & Meehl,

1955). Reflecting this, Cronbach (1988) distinguished two approaches to construct validation that had appeared in the literature: *strong approaches*, which depend on precise theory; and *weak approaches*, which could simply involve correlating one construct with another in the absence of a clearly defined theory. As a weak approach results in relatively uninformative validity evidence, stronger approaches are understandably advocated as the ideal (e.g., Borsboom et al., 2004; Clark & Watson, 2019; Cronbach, 1988; Kane, 2001; Messick, 1989; Strauss & Smith, 2009). However, psychology as a discipline has tended to neglect the importance of cumulative theoretical frameworks (Muthukrishna & Henrich, 2019), which could explain the imprecision often seen in many construct definitions. Furthermore, construct validation and theory validation are inextricably and reciprocally linked, with the construct validation process also providing evidence for the theory in which it is situated (Borsboom et al., 2004; Cronbach & Meehl, 1955; Kane, 2001; Smith, McCarthy, & Zapolski, 2009; Strauss & Smith, 2009). As such, a neglect of theory when validating a construct also severely limits the development of theory itself.

In practical terms, the first step in using theory to conceptualise a construct is to thoroughly review the extant literature (Clark & Watson, 2019; Flake et al., 2017; Podsakoff, MacKenzie, & Podsakoff, 2016). Conducting qualitative research (e.g., interviews, focus groups) is also a useful technique, and is particularly valuable when there is insufficient literature that is relevant to the construct of interest (Brod, Tesler, & Christensen, 2009; Podsakoff et al., 2016). By identifying appropriate theoretical frameworks with these techniques, the construct of interest can be defined in relation to existing constructs (Gerring, 1999; Smith et al., 2009). This involves conceptualising what a construct is, and also what it is not (Clark & Watson, 2019).

Situating the construct of interest within a theoretical hierarchy is particularly useful for producing a clear and precise conceptualisation (e.g., Clark & Watson, 2019). Adopting this view, constructs that are lower in the hierarchy are less complex, as they subsume fewer distinct sub-constructs (McGrath, 2005). For example, self-concept has been broadly defined as “a person’s perceptions of him- or herself” (Marsh & Shavelson, 1985, p. 107). By conceptualising self-concept as at the top of a

hierarchy of constructs, it can be parsed into academic and non-academic self-concepts, of which the latter can be further separated into social, emotional and physical self-concepts, and each of these into smaller constructs, *ad infinitum* (Shavelson, Hubner, & Stanton, 1976). Given the possibility of continually separating a construct into smaller parts, it is vital to consider when it is sufficiently 'elemental' (Strauss & Smith, 2009). Determining this requires judgement and justification from the researcher, as this issue cannot be addressed with statistics (Smith et al., 2009). As such, the principal guidance for determining whether a construct should be made more elemental is whether there is a reasonable theoretical justification for doing so (Gerring, 1999; Smith et al., 2009; Strauss & Smith, 2009). If there is such a justification, understanding and prediction would likely be improved by focusing on these smaller, more precise elements, rather than the higher-order construct they comprise (Strauss & Smith, 2009). For instance, taking the above example of self-concept, without theoretically parsing the construct, it would not be possible to make conclusions about academic or non-academic self-concepts, which prevents an understanding of these from developing. Overall, there is clear reason to believe that a greater research focus on simple, more elemental constructs will advance science, while focusing on complex constructs (i.e., consisting of several theoretical elements) will hinder these efforts (McGrath, 2005; Smith et al., 2009; Strauss & Smith, 2009).

1.2.3. Content validity

The conceptualisation of a construct has clear implications for the later phases of the construct validation process. For example, by theoretically situating a construct, it is possible to generate clearer external validity evidence, as variables with which convergent validity could be assessed are specified at the start of the validation process (Clark & Watson, 2019; Strauss & Smith, 2009). However, construct conceptualisation has more immediate implications for other aspects of the substantive phase. Specifically, there are implications for developing the content for a measure of the construct, and assessing the content's relevance and representativeness (Flake et al., 2017). It should be noted that references to a 'measure' encompass any tool used to assess a construct, as validity is as important

for self-report items and scales, as it is for experimental manipulations (Strauss & Smith, 2009).

Following a construct's conceptualisation, if no appropriate measure exists, one should be developed that assesses the attributes stated in the construct's definition (e.g., Clark & Watson, 1995; McGrath, 2005). If this definition is clear and precise, the development of a measure is made easier (Podsakoff et al., 2016). Taking the example of developing a self-report scale, this would first necessitate the writing of items that capture the breadth of the construct as defined (Clark & Watson, 2019). The broader the definition of a construct, the more items will be required (Furr, 2011). For example, if developing a measure for non-academic self-concept (having deemed this the appropriate level of conceptualisation), items would be required that assess social, emotional and physical self-concepts (cf. Shavelson et al., 1976).

After developing the elements of a measure (e.g., self-report items, response scales), the content validity of these should be carefully assessed, which involves establishing the extent to which they are "relevant to and representative of the target construct" (Haynes, Richard, & Kubany, 1995, p. 238). There is a general agreement that content validity requires qualitative and quantitative assessment (Haynes et al., 1995; Sireci, 1998a, 1998b). Typically, multiple raters independently judge the relevance of an element to assessing the target construct (e.g., Messick, 1989), and their ratings are compared to determine quantitatively their degree of consensus (e.g., Lawshe, 1975). Reflecting the importance of conceptualising what a construct is *not* (Clark & Watson, 2019), the irrelevance of an element to assessing a construct should also be considered (Dixon & Johnston, 2019; Sireci, 1998a). Additionally, when assessing the representativeness of a measure's content to the target construct, careful consideration is required to ensure that the measure assesses the entire construct, and does not focus on one attribute more than another (Carmines & Zeller, 1979; Dixon & Johnston, 2019). For example, in the case of self-concept detailed above (cf. Shavelson et al., 1976), social, emotional and physical attributes of non-academic self-concept should be equally represented within the construct's measure.

As previously discussed, the degree to which a construct is sufficiently elemental is a crucial consideration for construct conceptualisation, and has major implications for

a scale's content. Specifically, it is common for a measure to assess a complex construct (e.g., self-concept), with heterogeneous content that relates to more than one attribute (e.g., academic and non-academic self-concepts; McGrath, 2005). However, interpretations based on such a measure's overall score would be limited, as the extent to which each attribute contributes to the score would not be known (Dixon & Johnston, 2019; Furr, 2011; McGrath, 2005; Sireci, 1998a; Smith et al., 2009; Strauss & Smith, 2009). In other words, if a measure comprises heterogeneous content, it prevents precise conclusions from being made (e.g., how the measured construct relates to or predicts others). Consequently, scores resulting from measures that assess an elemental construct with homogenous content permit more accurate and precise conclusions to be made (e.g., McGrath, 2005; Smith et al., 2009).

While this section has made more explicit reference to the importance of content validity when developing measures, researchers should also consider the validity of an *existing* measure's content in relation to the target construct as they define it (Flake & Fried, 2019). However, it appears to be the case that researchers often select a measure based on its name, rather than sufficiently appraising its content (e.g., Weidman, Steckler, & Tracy, 2017). Such a practice can lead a researcher to commit either the *jingle* or *jangle* fallacy (Flake & Fried, 2019; Kelley, 1927; Larsen & Bong, 2016; Thorndike, 1904; Weidman et al., 2017).

The jingle fallacy relates to the mistaken assumption that because different measures are named similarly, they assess the same construct (Thorndike, 1904). For example, two self-report scales might nominally assess self-concept, but the content of one might primarily assess academic self-concept, whereas the other might primarily assess non-academic self-concept. If two such scales were used to make conclusions about the same construct (i.e., self-concept in general), variability in observed relationships would be misattributed to the construct itself, rather than differences in its measurement. The importance of not committing the jingle fallacy is emphasised by comparisons of measures that ostensibly assess the same construct (e.g., psychiatric disorders, such as depression, mania and obsessive-compulsive disorder; Chrobak, Siwek, Dudek, & Rybakowski, 2018; Fried, 2017; Visontay,

Sunderland, Grisham, & Slade, 2019). Taking the example of depression, a study identified seven self-report scales that are commonly used to make conclusions about depression in general (Fried, 2017). Overall, the scales assessed 52 distinct symptoms, although only six symptoms (12%) were assessed by all scales, and 21 (40%) were only represented in one scale. As a result, the 'depression' assessed by each of these scales is substantively different, which makes the comparison of two studies' findings difficult if they have each used a different measure of depression. The less the two measures' content overlaps, the more problematic the comparison will be.

In contrast, the jangle fallacy concerns differently named measures being mistakenly assumed to assess different constructs (Kelley, 1927). For example, two measures might consist of overlapping content, but label their target construct (and the measure itself) differently. This fallacy has been observed in psychological research as, across different measurement instances, several words (e.g., 'jittery', 'scared', 'worried') were used in self-report items to assess both anxiety and fear (Weidman et al., 2017). Consequently, while these two constructs are typically viewed as conceptually distinct (Weidman et al., 2017), important differences between anxiety and fear might be unidentified due to measures that assess them overlapping in content.

As with the other, previously discussed issues relating to substantive validity, insufficient consideration when selecting a measure has major implications for later phases of the construct validation process. However, the jingle and jangle fallacies can be avoided by ensuring that a measure's content matches the construct that one intends to assess.

1.2.4. Summary

Overall, the previous subsections have emphasised the criticality of substantive validity evidence to the construct validation process. Specifically, the case has been made for using theory to conceptualise elemental constructs, and then clearly and precisely defining these. The importance of ensuring that a measure's content aligns

with the definition of the target construct (i.e., content validity) has also been emphasised.

While a neglect of substantive validity affects later phases of the construct validation process (e.g., inaccurate assessments of convergent validity), it also has large implications for evidence synthesis. For example, syntheses of evidence (e.g., literature reviews, meta-analyses) do not commonly state the different measures used by studies, but rather group studies based on the construct of interest (Fried, 2017). As discussed, there are problems inherent with the comparison of studies that have used different measures, but have made conclusions about the same construct (i.e. the jingle fallacy). Consequently, syntheses of evidence that do not sufficiently consider content validity (or, more generally, substantive validity) risk making inaccurate conclusions about a construct. As reviews and meta-analyses are likely more influential on a field due to consolidating evidence from more than one study (cf. Murad, Asi, Alsawas, & Alahdab, 2016), it is vital that substantive validity is considered as important when synthesising evidence, as when conducting an individual study.

In line with the quotation at the beginning of this section on construct validity, as the neglect of substantive validity undermines construct validity, it also undermines the clinical utility of psychological research (Haynes et al., 1995). This issue is explored further in the next section, which concerns pathological eating and exercise constructs.

1.3. Eating and exercise psychopathology

As outlined in the previous section, construct validity has important clinical implications (Haynes et al., 1995). For example, more elemental and precise constructs facilitate more accurate clinical decisions to be made, and more targeted treatments to be developed (e.g., Clark & Watson, 2019; Dixon & Johnston, 2019; Smith et al., 2009; Strauss & Smith, 2009). Despite the benefits of elemental constructs, complex constructs are still pervasive in clinical settings, with psychiatric

disorders (e.g., depression, schizophrenia) representing a particularly important example.

Psychiatric disorders are usually classified using either the *Diagnostic and Statistical Manual of Mental Disorders* (DSM; American Psychiatric Association, 2013), or the *International Classification of Diseases* (ICD; World Health Organization, 1992). For a diagnosis of a psychiatric disorder to be made, a person must typically fulfil a minimum number of criteria associated with the specific disorder. For example, in the 5th edition of DSM, a diagnosis of depression (i.e., major depressive disorder), requires a person to experience at least five of nine symptoms (e.g., depressed mood, weight-change, fatigue, impaired concentration, suicidality). Although there are potential benefits of diagnostic categories (e.g., aiding a patient's understanding of their condition; e.g., Craddock & Mynors-Wallis, 2014), from the perspective of construct validity, the diagnoses present some major problems. First, the classifications of psychiatric disorders are not elemental, and therefore comprise a large degree of heterogeneity (e.g., Clark, Watson, & Reynolds, 1995; Cuthbert & Kozak, 2013; Smith et al., 2009). Indeed, in the example of the major depressive disorder category in DSM, two people might each experience five symptoms, but share only one of these. This parallels the previously detailed review of self-report measures of depression, which found that only 12% of the identified symptoms were assessed across all of the scales (Fried, 2017). Second, excessive comorbidities (i.e., fulfilling criteria for more than one disorder) suggest that diagnoses cannot be easily distinguished (e.g., Clark et al., 1995).

Reflecting the problems of psychiatric diagnostic categories, the United States of America's National Institute of Mental Health implemented the *Research Domain Criteria* project (RDoC; see Cuthbert & Kozak, 2013). In brief, RDoC emphasises the importance of construct validity, and aims to: identify the elemental components of psychiatric disorders (e.g., cognitions, emotions, social factors); characterise the components using several units of measurement (e.g., self-report, behaviours, physiology, genes); and determine the dimensionality of the components (i.e., variation from normal to pathological). The dimensional perspective adopted by RDoC necessitates that evidence for construct validity encompasses the component's

entire normal to abnormal range. As such, evidence for substantive validity (e.g., literature reviews, qualitative research) should be generated from appropriately varied samples (e.g., Cuthbert & Kozak, 2013; Wildes & Marcus, 2015). Such samples include clinical patients, people who seek treatment but do not receive a diagnosis, and people without a history of a specific psychiatric disorder.

Due to the previously described benefits of elemental constructs, the perspective adopted in this thesis is more aligned with RDoC's approach to psychiatric disorders (i.e., focusing on elemental components) than the approach of DSM or ICD (i.e., focusing on diagnostic categories). As such, an overview of constructs comprising eating disorders is now presented.

1.3.1. Eating psychopathology

Eating disorders are serious psychiatric disorders, and, using DSM and ICD, are diagnosed when a person presents with specific cognitive and behavioural symptoms related to their body and eating (e.g., restricting energy-intake, fear of weight-gain; American Psychiatric Association, 2013; World Health Organization, 1992). In the latest version of DSM, three specific eating disorders are included: anorexia nervosa, bulimia nervosa, and binge-eating disorder. However, in line with the problems with classifying psychiatric diagnoses, research has indicated a large degree of heterogeneity within each eating disorder diagnosis (e.g., Wildes & Marcus, 2015), and overlap between the diagnoses and other disorders (e.g., anxiety; Kaye et al., 2004). Furthermore, patients diagnosed with an eating disorder often move between diagnostic categories over time, such as meeting the criteria for bulimia nervosa after being diagnosed with anorexia nervosa (e.g., Cooper, 2017). In contrast to the diagnostic categories, dimensional and transdiagnostic approaches (e.g., Fairburn, 2008) mitigate these issues, and instead focus on identifying the core psychopathology of the eating disorders (i.e., 'eating psychopathology'). The value of such a dimensional approach to understanding eating disorders is clear, as the same symptoms can be observed across the diagnostic categories, but varying in their degree (Wildes & Marcus, 2015). For example, while control of energy-intake (i.e., restriction) is a symptom of anorexia nervosa in DSM-V, a *loss* of control of energy-

intake is symptomatic of bulimia nervosa and binge-eating disorder (American Psychiatric Association, 2013).

A vital step in developing a robust dimensional understanding of eating psychopathology is to consolidate the core constructs comprising eating disorders. A recent review addressed this by consolidating variables that were present within ten models of eating psychopathology (Pennesi & Wade, 2016). In line with DSM and ICD criteria for eating disorders (American Psychiatric Association, 2013; World Health Organization, 1992), Pennesi and Wade identified cognitive and behavioural constructs related to one's body and eating (e.g., preoccupation with weight and shape, thin-ideal internalisation, dieting, body-mass index, self-objectification, self-surveillance). However, the review also identified several constructs that are related to factors other than one's body and eating (e.g., self-esteem deficits, emotional regulation difficulties, negative affect, perfectionism, interpersonal factors, social comparison, developmental and genetic factors). As the constructs identified by Pennesi and Wade are broader than those comprising DSM and ICD criteria, the high prevalence of comorbidities in eating disorder patients (e.g., Kaye et al., 2004) is unsurprising (e.g., negative affect being symptomatic of several mood disorders).

The models of eating psychopathology reviewed by Pennesi and Wade (2016) were selected if they had informed the development of an intervention that had subsequently been evaluated through pilot, efficacy and/or effectiveness testing. A summary of these ten models is presented in Table 1, and provides an overview of the constructs identified by Pennesi and Wade within each model.

Table 1. Constructs identified in models of eating psychopathology

Model	Constructs identified within model (cf. Pennesi & Wade, 2016)																	
	Biogenetic predisposition	Body-mass index	Cognitive factors	Developmental factors	Dieting	Emotional regulation difficulties	External pressure	Health & nutrition attitudes	Interpersonal issues	Negative affect	Perfectionism	Preoccupation with weight and shape	Self-esteem deficits	Self-objectification	Self-surveillance	Social comparison	Social support	Thin-ideal internalisation
1. Acceptance model of intuitive eating[a]												✓		✓			✓	
2. Cognitive model of bulimia nervosa[b]			✓	✓	✓	✓				✓		✓						
3. Cognitive-interpersonal maintenance model of anorexia nervosa[c]			✓			✓			✓		✓							
4. Dual-pathway model of bulimia nervosa[d]					✓		✓			✓		✓						✓
5. Functional model of emotion avoidance in anorexia nervosa[e]						✓				✓								
6. Interpersonal model of binge eating[f]		✓				✓			✓	✓			✓					
7. Model of disordered eating[g]		✓				✓	✓	✓	✓			✓						
8. Multidimensional model of anorexia nervosa[h]	✓								✓				✓		✓			
9. Transdiagnostic maintenance model of anorexia nervosa and bulimia nervosa[i]						✓			✓		✓	✓	✓					
10. Tripartite influence model of body dissatisfaction and disordered eating[j]							✓					✓	✓			✓		✓

[a]Augustus-Horvath and Tylka (2011); [b]Cooper, Todd, and Wells (2009); [c]Treasure and Schmidt (2013); [d]Stice (2001); [e]Wildes, Ringham, and Marcus (2010); [f]Wilfey, MacKenzie, Welch, Ayers, and Weissman (2000); [g]Neumark-Sztainer, Wall, Story, and Perry (2003); [h]Lyon et al. (1997); [i]Fairburn (2008); [j]Yamamiya, Shroff, and Thompson (2008)

Of the constructs appearing in more than two models of eating psychopathology (Table 1), 'preoccupation with weight and shape' and 'emotional regulation difficulties' were the most commonly identified, appearing in six models each. A preoccupation with weight and shape is typically viewed as a dissatisfaction with one's body (Augustus-Horvath & Tylka, 2011; Cooper et al., 2009; Fairburn, 2008; Neumark-Sztainer et al., 2003; Stice, 2001; Yamamiya et al., 2008). As well as body dissatisfaction, several models emphasise general (i.e. not directly related to one's body) negative affect (e.g., anxiety, depression, low self-esteem) as playing a central role in eating psychopathology (Cooper et al., 2009; Fairburn, 2008; Lyon et al., 1997; Stice, 2001; Wildes et al., 2010; Wilfey et al., 2000; Yamamiya et al., 2008). In relation to negative affect that is related and unrelated to one's body, emotional regulation difficulties are viewed as maintaining eating psychopathology, as they are argued to lead to the enactment of related behaviours (e.g., restriction, purging, bingeing) as a way of avoiding negative emotions (Cooper et al., 2009; Fairburn, 2008; Neumark-Sztainer et al., 2003; Treasure & Schmidt, 2013; Wildes et al., 2010; Wilfey et al., 2000). The enactment of such behaviours is argued to maintain eating psychopathology by creating a vicious cycle, such as by negatively impacting interpersonal relationships (e.g., Treasure & Schmidt, 2013), or reinforcing negative affect (e.g., Cooper et al., 2009). A perfectionistic thinking style is also suggested to contribute to this cycle by, for example, perceiving an inability to manage one's weight as a failure, which might consequently lead to negative affect (Fairburn, 2008; Treasure & Schmidt, 2013). In addition to these characteristics of the individual, several models highlight the importance of external factors, such as poor interpersonal relationships leading to negative affect (Fairburn, 2008; Lyon et al., 1997; Neumark-Sztainer et al., 2003; Treasure & Schmidt, 2013; Wilfey et al., 2000). Socio-cultural pressure to pursue the 'thin-ideal' (i.e., a thin body) is also argued to be particularly influential in the development of body dissatisfaction (Stice, 2001; Yamamiya et al., 2008).

While Pennesi and Wade's review (2016) clearly outlines the breadth of constructs that should be considered in relation to eating psychopathology, the imprecision of these constructs might prevent them from having a high level of clinical utility (e.g.,

Strauss & Smith, 2009). For example, 'preoccupation with weight and shape' was conceptualised as comprising several more elemental variables (e.g., 'weight & shape concern', 'body dissatisfaction', 'appearance anxiety'). Therefore, while two interventions might nominally focus on preoccupation with weight and shape, one intervention might target body dissatisfaction, while the other might target appearance anxiety (cf. jingle fallacy, Thorndike, 1904). In contrast, the variables comprising the constructs might overlap in terms of their conceptualisations, despite being named differently (cf. jangle fallacy, Kelley, 1927). For example, two interventions that ostensibly target different variables, might actually be targeting the same, more elemental construct that is captured by both of these variables. Further refinement of the constructs identified by Pennesi and Wade (2016) is therefore required.

1.3.2. Compulsive exercise

No constructs identified by Pennesi and Wade (2016) explicitly relate to exercise, although it could fall within the 'dieting' construct as an 'unhealthy weight-control behaviour'. However, while exercise can undoubtedly play a role in weight-control, it is indicated to play other important roles in relation to eating psychopathology (e.g., affect regulation; Bratland-Sanda et al., 2011).

The absence of an explicit reference to exercise – or, more generally, physical activity – in Pennesi and Wade's (2016) constructs reflects arguments that unhealthy exercise is neglected in eating disorder research (Touyz, Hay, & Noetel, 2017). A potential reason for its neglect is conceptual in nature, as there is no consensus on how to define unhealthy exercise in the context of eating psychopathology (Noetel, Dawson, Hay, & Touyz, 2017). Indeed, physical activity of clinical importance is defined in various ways, with the associated terms often used interchangeably (e.g., 'compulsive', 'obligatory' or 'excessive' exercise, or exercise 'addiction' or 'dependence'; Meyer & Taranis, 2011). Adkins and Keel (2005) attempted to consolidate the varied definitions of unhealthy exercise, and argued that the definitions typically relate to either quantitative aspects (e.g., frequency, duration, intensity) or qualitative aspects (e.g., rigidity, guilt, anxiety) of physical activity. Building on this distinction, research assessing both aspects of exercise has typically

indicated that qualitative aspects are particularly important to understand in relation to eating psychopathology (Ackard, Brehm, & Steffen, 2002; Adkins & Keel, 2005; Bardone-Cone et al., 2016; Boyd, Abraham, & Luscombe, 2007; Holland, Brown, & Keel, 2014).

In an attempt to develop a consensus for the definition of unhealthy exercise in the context of eating psychopathology, 25 experts were asked to provide their definitions of unhealthy exercise (Noetel et al., 2017). Regarding the characteristics for which there was a consensus (i.e., ≥85% experts agreed), unhealthy exercise was defined as: excessive in quantity (i.e., duration, frequency and intensity); used to compensate for calorie-intake; and performed rigidly, in secret, and despite injury, illness or pain. Consensus was also reached that unhealthy exercise was characterised as: difficult for the person to reduce in quantity; interfering with other aspects of the person's life; resulting in distress (e.g., guilt, anxiety) if unable to be performed; and being thought about excessively or in a distorted way. While the prespecified level of consensus was not reached, the majority of the experts (*n*=15, 60%) used the term 'compulsive exercise' to describe unhealthy exercise.

The five-factor Compulsive Exercise Test (CET; Taranis, Touyz, & Meyer, 2011) was developed in response to the need for a self-report scale that assesses the breadth of the compulsive exercise construct. While the five-factor structure has received further support (Meyer et al., 2016; Sauchelli et al., 2016; Vrabel & Bratland-Sanda, 2019), this has not been consistently validated (Formby, Watson, Hilyard, Martin, & Egan, 2014; Limburg et al., 2019; Swenne, 2016). However, in line with the initial five-factor structure, the CET nominally assesses: avoidance and rule-driven behaviour (i.e., negative mood arising from not exercising, and exercising despite injury or illness); weight-control exercise (i.e., exercise to improve appearance, burn calories, and lose weight); mood improvement (i.e., more positive and less negative mood after exercise); lack of exercise enjoyment; and exercise rigidity (i.e., repetitive, organised and routine patterns of exercise). As such, the content of the CET can be seen to capture the majority of qualitative aspects of unhealthy exercise that the consultation with experts outlined as being important (Noetel et al., 2017).

Furthermore, the CET also assesses a lack of exercise enjoyment, an aspect that was one percent below the consensus threshold in Noetel and colleagues' study.

Reflecting that debates about the definition of compulsive exercise are ongoing (e.g., Bratland-Sanda, Mathisen, Sundgot-Borgen, & Rosenvinge, 2019; Dittmer, Jacobi, & Voderholzer, 2018), the assessment of compulsive exercise will continue to require refinement. For example, the secretive nature of exercising highlighted in the consensus study (Noetel et al., 2017) is not captured in the CET, nor are aspects that were included in earlier definitions of compulsive exercise, such as keeping detailed records of one's exercise (e.g., Adkins & Keel, 2005). Indeed, related to record keeping, studies have indicated that patients with eating disorders tend to underreport their amount of exercise (Bezzina et al., 2019; Bratland-Sanda et al., 2010; Kolnes, 2016). Consequently, in the context of eating psychopathology, the way in which a person monitors and records their physical activity is a potentially important issue that requires further research, as well as the construct of compulsive exercise in general.

1.3.3. Summary

Through providing an overview of eating and exercise psychopathology, the challenges facing research in this area are apparent. For example, compulsive exercise is considered to comprise a variety of aspects, such as having rigid exercise patterns, experiencing negative affect from a lack of exercise, and using exercise to compensate for energy-intake. As a result, it is problematic to interpret an overall score from a measure that assesses these varied aspects of compulsive exercise (e.g., CET; Taranis et al., 2011). Specifically, the contribution of each aspect is not captured in the overall score, meaning that different presentations of compulsive exercise would not be reflected in the single value.

While analyses of subscales can provide a more detailed picture than an overall score, heterogeneity in a scale's content is still an issue. Indeed, in the example of the 'avoidance and rule-driven behaviour' subscale in the CET, there are separate items relating to negative affect, and exercising despite injury or illness (Taranis et al., 2011). Accordingly, network analyses of item-level relationships have grown in

popularity in the area of eating psychopathology. For example, in the first study to use a network analysis for this purpose, a network was computed based on the correlations between each pairing of 45 items that assess different aspects of eating psychopathology (Forbush, Siew, & Vitevitch, 2016). The most influential items within the network were then identified by calculating the structural properties of the network, with Forbush and colleagues observing 'body checking' to be the most important symptom in this regard. However, although such item-level analyses might enable more precise conclusions to be drawn, caution must still be taken in the interpretation of findings, as it is likely that the content assessed by the item is narrow in scope. Consequently, the label and definition of the construct assessed by the item should be similarly narrow in scope to avoid the jingle fallacy being committed (i.e., assuming that the item content assesses the broader construct). Indeed, while the most influential symptom in Forbush and colleagues' analysis was labelled 'body checking', this construct is typically associated with a wider range of content than represented in their item wording ('I tried on different outfits, because I did not like how I looked'; 2016).

As demonstrated by Forbush and colleagues (2016), body checking is a particularly important eating disorder symptom for clinicians and researchers to consider. Indeed, the construct is of particular importance regarding the aims of this thesis. Specifically, while body checking nominally represents the monitoring of one's body, the topic of this thesis broadly relates to the monitoring of one's physical activity. Therefore, due to both constructs representing a form of monitoring, a theoretical appraisal of body checking could highlight issues to consider in relation to physical activity self-monitoring. As such, the next chapter focuses on the body checking construct to: identify and apply theory to enhance the conceptualisation of a self-monitoring construct (section 2.1.); and critically appraise the content of self-report scales that are typically used to assess body checking (section 2.2.).

2. Physique self-monitoring:

Refining the ‘body checking’ construct

2.1. Conceptualisation of body checking

The previous chapter outlined the importance of the construct validation process, and the complexity of pathological eating and exercise constructs. A particularly important pathological eating and exercise construct is 'body checking' (e.g., Forbush et al., 2016), which is argued to maintain over-concern about one's shape and weight (Fairburn, Cooper, & Shafran, 2003). While such monitoring of one's body is considered important in relation to eating and exercise psychopathology, monitoring one's behaviours that impact body shape and weight (e.g., eating, physical activity) appear to have been less considered. Indeed, conceptualising the monitoring of one's physical activity in relation to eating and exercise psychopathology is the central aim of this thesis. Due to the apparent overlap between monitoring one's physical activity and body checking (i.e., both involve monitoring aspects of oneself), the same theory can likely be used to inform the conceptualisation of both constructs. Therefore, before developing a novel construct – pathological physical activity self-monitoring – this chapter presents a critical appraisal of the conceptualisation of a related, existing construct – body checking. Specifically, theory related to the monitoring of aspects of oneself is identified and used to appraise the extent to which body checking is elemental (cf. Strauss & Smith, 2009).

2.1.1. Body checking

Reflecting a purported overlap between eating disorders and anxiety disorders, body checking has been conceptualised as a safety-seeking behaviour (Pallister & Waller, 2008). Safety-seeking behaviours are a type of behaviour often enacted by people with high levels of anxiety (e.g., Tang et al., 2007), and are ostensibly used as a means of increasing one's control in a threatening situation and reducing one's anxiety (e.g., Salkovsis, 1991). For example, weighing oneself might alleviate one's fears of being fat. However, while safety-seeking behaviours might be effective at reducing the anxiety one experiences in the short-term, these behaviours are suggested to become counter-productive (e.g., Meulders, Van Daele, Volders, & Vlaeyen, 2016). Specifically, by regularly enacting a safety-seeking behaviour, an individual is

suggested to misattribute the feeling of safety to the behaviour itself (e.g., weighing oneself) rather than the source of their anxiety (e.g., thoughts about their body). As a result, the source of anxiety is not addressed, which potentially maintains one's anxiety (e.g., Norton & Paulus, 2017), which, in the case of body checking, might take the form of over-concern about one's shape and weight (cf. Fairburn et al., 2003).

Despite body checking being particularly important regarding the development and maintenance of eating disorders (e.g., Fairburn et al., 2003; Forbush et al., 2016), its conceptualisation and definition are often imprecise. As systematic reviews and meta-analyses are considered to be at the top of the hierarchy of evidence (cf. Murad et al., 2016), and are therefore likely to be viewed as particularly authoritative, the definitions of body checking from two recent reviews concerning the construct will be considered (Nikodijevic, Buck, Fuller-Tyszkiewicz, de Paoli, & Krug, 2018; Walker, White, & Srinivasan, 2018).

Both reviews referenced the transdiagnostic model of eating disorders (Fairburn et al., 2003) that conceptualises body checking (and 'body avoidance') as overt behavioural manifestations of core eating disorder symptomatology (e.g., overvaluing one's body shape or weight; Nikodijevic et al., 2018; Walker et al., 2018). More specifically, Nikodijevic and colleagues defined body checking as "an individual's tendency to critically scrutinise and repeatedly check their weight and shape through behaviours such as ritualistic weighing, compulsive mirror checking, and using the fit of clothes to judge weight changes" (2018, pp.159-160). In contrast, Walker and colleagues defined it as "repeated behaviors aimed at assessing one's shape, size, or weight" (p746; 2018). As detailed, both definitions referred to the 'repeated' nature of body checking behaviours, and that they involve 'assessing' or 'check[ing]' attributes of one's body (i.e., 'shape', 'weight'). However, Nikodijevic and colleagues provided further detail by giving specific examples (e.g., 'mirror checking', 'weighing'), and making greater use of descriptive language (e.g., 'critically scrutinise', 'ritualistic', 'compulsive').

Constructs should be clearly and precisely conceptualised and defined (e.g., Clark & Watson, 2019). In relation to this, Walker and colleagues' definition is arguably clearer and more precise, as behaviours that are or are not encompassed by the

definition can be distinguished in terms of whether or not they assess one's body shape, size or weight. In contrast, by including more descriptive language, it is less clear what behaviours are situated within Nikodijevic and colleagues' definition. For example, while weighing oneself could be viewed as a way in which to 'critically scrutinise' one's body (i.e., a body checking behaviour by their definition), looking at one's reflection in a car window could be viewed as insufficiently thorough to be defined as body checking. In other words, the descriptive language leads to making a more subjective (i.e., less precise) judgement regarding which behaviours are and are not body checking.

While both definitions are comparable, Nikodijevic and colleagues' definition is narrower (i.e., more elemental), as it ostensibly does not include more cursory behaviours that are encompassed by Walker and colleagues' definition. While precise constructs are recommended, the decision whether or not to make a construct more elemental relies on having a theoretical justification to do so (e.g., Smith et al., 2009). In the absence of a clearly stated theoretical justification, it is therefore difficult to determine whether or not Nikodijevic and colleagues' definition of body checking is too elemental. Consequently, it is beneficial to situate body checking within an appropriate theoretical framework to identify what the construct should and should not encompass.

2.1.2. Behaviour change taxonomies

The aim of parsing complex issues into more elemental parts is central to recent initiatives in the area of behaviour change. Specifically, in response to behaviour change interventions usually being highly complex (e.g., influencing behaviours in many ways), taxonomic approaches have been developed to identify and define elemental aspects of these interventions that facilitate behaviour change (i.e., 'behaviour change techniques'; e.g., Michie et al., 2011; Michie et al., 2013). For example, the behaviour change technique taxonomy was developed by consulting 54 experts in behaviour change, and comprises 16 categories of behaviour change techniques (e.g., 'Goals and planning', 'Feedback and monitoring', 'Social support'; Michie et al., 2013). Overall, the taxonomy consists of 93 behaviour change techniques, with varying numbers of these comprising each category (e.g., 'Goals and

planning' comprises 9 techniques, including 'Goal-setting (behaviour)' and 'Problem-solving'). In line with the importance of conceptualising both what a construct is and is not (Clark & Watson, 2019), all 93 techniques are considered 'non-overlapping' (Michie et al., 2013), and therefore represent precise and clearly differentiated ways of facilitating behaviour change.

Applying a behaviour change technique taxonomy can improve the clarity and precision in the reporting of interventions, which has several consequential benefits (Michie et al., 2013). For example, the improved reporting enhances the description and comparison of interventions, as demonstrated by a behaviour change taxonomic analysis of five eating disorder treatment manuals (Leonidas, Nazar, Munguia, & Santos, 2019). This analysis found that the interventions varied regarding the number of behaviour change techniques they included (ranging from 30% to 72.5% of the possible techniques), and identified the most common techniques in the interventions (i.e., goal-setting, action-planning, setting graded tasks, motivational interviewing). In addition to interventions, these taxonomies can also enhance the description and comparison of how different technologies influence behaviour. For example, taxonomic analyses of devices and apps related to weight, diet and physical activity have provided insight into how these technologies influence behaviour (e.g., Conroy, Yang, & Maher, 2014; Direito et al., 2014; Lyons, Lewis, Mayrsohn, & Rowland, 2014; Mercer, Li, Giangregorio, Burns, & Grindrod, 2016; Middelweerd, Mollee, van der Wal, Brug, & te Velde, 2014). Specifically, behaviour change techniques within the 'Goals and planning' and 'Feedback and monitoring' categories (cf. Michie et al., 2013) were particularly prevalent in these technologies.

As a consequence of these clearer and more precise descriptions, these taxonomies facilitate the accurate replication and implementation of interventions, as the enhanced definitions reduce ambiguity regarding what the interventions involve (Michie et al., 2013). Similarly, this accuracy improves the synthesis of evidence, as more informed decisions can be made when identifying appropriate evidence (e.g., including studies in a review that manipulate specific behaviour change techniques). Through synthesising evidence in relation to behaviour change techniques, the most effective of these can then be identified, which could also enable the development

of more effective interventions (Michie et al., 2013). Taken together, these benefits further exemplify how valid constructs (e.g., clearly and precisely defined behaviour change techniques) underpin the clinical utility of research (cf. Clark & Watson, 2019; Haynes et al., 1995).

Taking the example of body checking, this construct is clearly reflected in the behaviour change technique 'Self-monitoring of outcome(s) of behaviour', which is defined as "Establish[ing] a method for the person to monitor and record the outcome(s) of their behaviour as part of a behaviour change strategy" (Michie et al., 2015, p.120). Indeed, the example given for this technique is to ask an intervention participant to weigh themselves daily, which is clearly captured within the definitions of body checking presented above. It should be noted that the language in the taxonomic approach reflects that the definitions relate to a professional delivering an intervention (e.g., "Establish a method for the person"). However, this thesis primarily concerns how an individual performs a behaviour change technique that influences their own behaviour (i.e., establishing a method for themselves; cf. Knittle et al., 2020), which is reflected in both definitions of body checking: "*an individual's* tendency to […] check *their* weight and shape" (Nikodijevic et al., 2018); and "*assessing one's* shape, size, or weight" (Walker et al., 2018).

A last benefit of behaviour change taxonomies is that the techniques can be linked with theories to investigate *how* they influence behaviour (i.e., their mechanisms of action; Michie et al., 2013). Therefore, framing body checking as the technique 'Self-monitoring of outcome(s) of behaviour' facilitates the identification of appropriate theory, which can then be used to enhance the conceptualisation of the construct (cf. Strauss & Smith, 2009).

2.1.3. Control theory

Two self-monitoring behaviour change techniques feature in Michie and colleagues' taxonomy (2013; 2015): self-monitoring a behavioural outcome, of which body checking is an example; and self-monitoring a behaviour (e.g., physical activity). Considering both of these together, meta-analyses and reviews commonly report that self-monitoring is a particularly effective behaviour change technique (Brannon

& Cushing, 2015; Dombrowski et al., 2012; Greaves et al., 2011; Harkin et al., 2016; Michie, Abraham, Whittington, McAteer, & Gupta, 2009; Olander et al., 2013; Samdal, Eide, Barth, Williams, & Meland, 2017). While self-monitoring features in other theories (e.g., social cognitive theory of self-regulation; Bandura, 1991), these meta-analyses and reviews predominantly conceptualise the technique within control theory (Carver & Scheier, 1982), which is perhaps due to these studies also supporting the effectiveness of other behaviour change techniques derived from this theory (e.g., goal-setting; Michie et al., 2009).

Control theory provides a parsimonious account of the self-regulatory process. At its core, the process involves the perception of one's current state, and subsequent comparison of this state to a reference value (Carver & Scheier, 1982). The perception of one's current state is synonymous with self-monitoring, and involves attending to qualities of the target behaviour or outcome (Harkin et al., 2016). In the example of body checking (i.e., self-monitoring a behavioural outcome), this might constitute using a set of scales to note one's current weight. A person then compares their current state (e.g., 91kg) to a reference value (e.g., 83kg) to detect discrepancies between the two (e.g., one's current weight exceeding the reference value by 8kg). Reference values can take different forms, such as a past state (e.g., one's weight a year ago), a desired future state (e.g., a 'healthy' weight in accordance with national guidelines), or another person's state (e.g., a peer's weight; Harkin et al., 2016).

Following the detection of a discrepancy between one's current state and reference value, control theory posits that a feedback loop operates to reduce this (Carver & Scheier, 1982; Harkin et al., 2016; Kanfer, 1970; Prestwich, Conner, Hurling, Ayres, & Morris, 2016). Specifically, the discrepancy is viewed as motivating behaviour to bring one's current state in line with the reference value. For example, if a person's current weight is 8kg heavier than their ideal, they might change their behaviour to address this (e.g., eat less, exercise more). Subsequent self-monitoring then assesses the impact of this behaviour change on one's current state, which continues until there is no discrepancy between one's current state and the reference value (i.e., forming the feedback loop). Alternatively, if the discrepancy is not reduced, a person might revise or replace their existing reference value (e.g., de Bruin et al., 2012).

Due to the popularity and empirical support for control theory (e.g., Michie et al., 2009; Prestwich et al., 2016), and the clarity with which it conceptualises self-monitoring and the wider self-regulatory process, it represents a useful theoretical framework to enhance the conceptualisation of body checking. Indeed, a recent study explicitly situated body checking within control theory to identify other important variables to assess, namely the desirability of a 'thin-ideal' goal (i.e., reference value) and the frequency of weight-loss dieting (i.e., behaviours arising from a perceived discrepancy; Dalley et al., 2019). Through conducting a cross-sectional mediation analysis, Dalley and colleagues reported statistically significant positive associations between each pairing of these variables. Additionally, body checking was found to significantly mediate the (cross-sectional) relationship between the desirability of the thin-ideal goal and weight-loss dieting.

Through situating body checking within control theory, Dalley and colleagues' (2019) study exemplified how the conceptualisation of a construct can be enhanced by applying a theoretical framework. Specifically, by identifying other related variables (e.g., reference values), it is possible to state more clearly what body checking is, and what it is not (cf. Clark & Watson, 2019). The importance of this issue is more apparent when appraising a measurement tool, as a clearer understanding of related variables can enable the detection of heterogeneity within a tool's content (e.g., McGrath, 2005). This issue is thoroughly explored in the next section. However, before this, a final important aspect of self-monitoring is outlined: the nature of how it is enacted.

2.1.4. Nature of self-monitoring

As stated above, the behaviour change technique taxonomy differentiates between self-monitoring that focuses on a behavioural outcome (e.g., weight), and self-monitoring that focuses on a behaviour (e.g., physical activity; e.g., Michie et al., 2015). This represents an important distinction as a meta-analysis has indicated, unsurprisingly, that self-monitoring an outcome has a larger effect on the outcome than on associated behaviours (Harkin et al., 2016). Similarly, self-monitoring a behaviour was found to have a larger effect on the behaviour than on associated outcomes. This finding is in line with the theory of goal systems (Kruglanski et al.,

2002), which argues that the achievement of a goal can be influenced by several behaviours. For example, if one's goal were to lose weight, monitoring only physical activity might be ineffective as it neglects the effect of other behaviours (e.g., diet). Extending this example, it is arguably also important to consider more specific targets of self-monitoring. For example, if one wants to lose weight, it might be more effective to focus on specific body parts (e.g., stomach) over others (e.g., arms). Similarly, if one wants to run faster, monitoring one's speed during a run is likely to be more effective than monitoring the distance covered.

In addition to its focus, the form of self-monitoring can also vary considerably, which parallels calls for greater consideration of how a behaviour change technique is delivered (Dombrowski, O'Carroll, & Williams, 2016; Perski, Blandford, West, & Michie, 2016). For example, self-monitoring might involve using paper records, mobile devices, or one's memory (e.g., Abril, 2016). More specifically, in the case of body checking, self-monitoring might involve looking in the mirror, weighing oneself, or pinching parts of one's body (e.g., Reas, Whisenhunt, Netemeyer, & Williamson, 2002). The importance of this issue is supported by Harkin and colleagues' meta-analysis (2016), which reported that the form of self-monitoring influences its effectiveness at facilitating the achievement of a goal. Reflecting suggestions that the form of self-monitoring influences how information is understood (cf. Dombrowski et al., 2012), whether or not self-monitoring is quantified is also argued to be an important consideration (Chang, Webb, Benn, & Stride, 2017). Specifically, by reducing the output from self-monitoring to a number, important information might not be considered. For example, if a person only assesses their body in terms of a numerical weight, a stable number over time might conceal changes in the composition of their body (e.g., fat, muscle).

For any given form and focus of self-monitoring, its effectiveness is argued to vary depending on how an individual engages in it (Dombrowski et al., 2016). In the context of interventions, engagement is emphasised to be multifaceted, comprising various behavioural aspects (Perski et al., 2016). These include 'duration' (e.g., how many weeks someone weighs themselves), 'frequency' (e.g., the number of times one weighs themselves in a specific duration), 'amount' (e.g., the length of each bout

of self-weighing), and 'depth' (e.g., considering information about other focuses, such as fat or muscle). Other examples are outlined in the social cognitive theory of self-regulation (Bandura, 1991; Tougas, Hayden, McGrath, Huguet, & Rozario, 2015), such as self-monitoring a focus close in time to when it occurs (i.e., 'temporal proximity'), and self-monitoring regularly (i.e., 'consistency'). Of these behavioural aspects, the frequency of self-monitoring has received the most research attention, with Harkin and colleagues' meta-analysis (2016) finding that a higher frequency of self-monitoring predicted greater achievement of one's goal. Several reviews support this in relation to the body, having consistently indicated a positive association between frequent self-weighing (i.e., one focus and form of body checking) and weight-loss (Benn, Webb, Chang, & Harkin, 2016; Burke, Wang, & Sevick, 2011; Madigan, Daley, Lewis, Aveyard, & Jolly, 2015; Shieh, Knisely, Clark, & Carpenter, 2016; Vanwormer, French, Pereira, & Welsh, 2008; Zheng et al., 2015).

Engagement is also conceptualised as comprising subjective experiences (e.g., attention, interest, affect), and being influenced by various individual characteristics (e.g., demographics, psychosocial factors; Perski et al., 2016). Indeed, one's preference for the form of self-monitoring has been indicated to influence adherence to a behaviour change intervention (Shay, Seibert, Watts, Sbrocco, & Pagliara, 2009). Furthermore, when monitoring one's progress toward a goal, Bandura (1991) emphasised how mental health might influence one's subjective experience of engagement. Specifically, through setting higher ideal standards and minimising success regarding goal achievement, it was suggested that people with higher levels of depressive symptoms are more likely to experience negative affect (e.g. stress, despondence). Regarding eating psychopathology, both reviews of body checking studies (Nikodijevic et al., 2018; Walker et al., 2018) concluded a positive association between eating psychopathology and the frequency of body checking. However, reviews of the effects of frequent self-weighing on eating psychopathology reported more variable findings (Benn et al., 2016; Pacanowski, Linde, & Neumark-Sztainer, 2015; Shieh et al., 2016; Zheng et al., 2015). Relatedly, compared to unrestrained eaters, experimental research found that when restrained eaters were informed falsely that they weighed more than they actually did, they experienced lower self-

esteem, and higher anxiety and energy-intake (McFarlane, Polivy, & Herman, 1998). In contrast, restrained eaters' energy-intake was less affected by false energy-expenditure feedback for an exercise bout than unrestrained eaters (McCaig, Hawkins, & Rogers, 2016). While the reasons for the discrepancies in these experiments require further research (e.g., the alignment of false feedback with one's goal), together with the reviews of body checking and self-weighing, they highlight the importance of improving the understanding of how eating psychopathology and self-monitoring are related.

While this subsection has considered different aspects of self-monitoring separately (e.g., focus, form, engagement), in practice, these are interrelated. Most clearly, some focuses are likely to be monitored using specific forms, such as one's weight being assessed with scales, or the number of steps being tracked with a pedometer. The form of self-monitoring has also been found to influence one's engagement. For example, the quantification of focuses, and the use of digital devices (e.g., pedometers, smartphones, wearables) have both been observed to increase the frequency of self-monitoring (e.g., Abril, 2016; Chang et al., 2017; Harkin et al., 2016). However, studies often insufficiently assess or control for these aspects. For example, in a study comparing the monitoring of one's physical activity using paper records or a digital device, fewer people in the paper record condition were found to achieve their goal (Conroy et al., 2011). While the findings might indicate that a digital device is more effective for behaviour change, the differing focuses between the conditions confound this result. Specifically, in the paper record condition, participants only recorded the duration (i.e., minutes) of their physical activity, while those in the digital device condition recorded the duration and several other focuses (i.e., perceived intensity, type, daily steps, amount of resistance, repetitions of muscle-strengthening exercises). As a result of not controlling for either the forms or focuses in the study (e.g., holding the focuses constant across conditions), it is not possible to ascertain whether the observed effect was due to one or both of these aspects. As exemplified, it is therefore important for future research to assess or control for each of these aspects to improve the understanding of how they are related, and ensure that findings are correctly interpreted.

2.1.5. Physique self-monitoring

To summarise this section, by situating body checking within control theory (cf. Dalley et al., 2019), a clearer conceptualisation of what the construct does and does not represent is possible. Namely, in line with recent definitions (Nikodijevic et al., 2018; Walker et al., 2018), body checking reflects self-monitoring (i.e., a technique enacted to perceive one's current state), and can be distinguished from comparisons to reference values (i.e., target states). Reflecting the importance of the focuses of self-monitoring, the term 'body' is relatively imprecise. Indeed, rather than referring to the body, both definitions of body checking in the reviews refer to the assessment of 'shape' and 'weight' (Nikodijevic et al., 2018; Walker et al., 2018), with Walker and colleagues also specifying 'size'. As such, the term 'physique' is arguably more precise, as it emphasises the assessment of these aspects (i.e., shape, size, weight). Accordingly, from this point onward, this thesis will predominantly refer to the construct of 'physique self-monitoring', which is defined as follows:

> "Any technique that a person enacts to assess their overall, or aspects of their, current physique (i.e., the shape, size and weight of their body). These techniques constitute one aspect of comparisons, and are conceptually distinct from, and do not encompass reference values (i.e., a target physique)."

Regarding this definition, qualities of self-monitoring (e.g., 'critically scrutinise', 'ritualistic', 'compulsive'; Nikodijevic et al., 2018) are not specified to maintain clarity that physique self-monitoring concerns the specific techniques one enacts (e.g., weighing oneself). Similarly, no reference is made to the 'repeated' nature of these techniques to be inclusive of the breadth of the engagement construct (i.e., aspects other than frequency).

Having outlined the complexities of body checking in this section, the refined conceptualisation (i.e., physique self-monitoring) is used in the next section (Study 1), which presents a review of the assessment of body checking in the literature.

2.2. Study 1: Content analysis of body checking scales

Physique self-monitoring represents a theoretical refinement of the existing construct of body checking. Specifically, physique self-monitoring explicitly distinguishes techniques enacted to monitor one's current physique (e.g., looking in the mirror, pinching parts of one's body) from related constructs (i.e., comparisons to reference values; cf. Carver & Scheier, 1982). A construct's conceptualisation has direct implications for the content of its measurement tools (e.g., Flake et al., 2017). Consequently, the theoretically guided definition of physique self-monitoring can be used to appraise the heterogeneity of the content of existing body checking self-report scales, which was the primary aim of the study reported in this section. By conducting this critical appraisal of body checking scales, the current study aimed to exemplify the extent to which construct validity – and, particularly, substantive validity evidence – is neglected in the area of eating and exercise psychopathology.

In a previously detailed comparison of the content of seven depression self-report scales (Fried, 2017), 52 distinct symptoms were identified by inductively reviewing the items comprising the scales. The presence or absence of each symptom within a scale's content (i.e., items) was then dichotomously coded, which enabled the comparison of the scales regarding the symptoms they did or did not assess. However, while the presence or absence of a symptom in a scale's content is insightful, it is also important to understand the *extent* to which a symptom is assessed by a scale. For example, if a scale assesses three symptoms, it is important to know whether an equal number of items relates to each symptom. If the symptoms are equally assessed, the overall score can be viewed as representative of the three symptoms. However, if the scale's items tend to assess one symptom more than the others, its overall score would be biased.

For the study reported in this section, body checking scales were identified by consulting the two previously outlined reviews and meta-analyses of body checking studies (Nikodijevic et al., 2018; Walker et al., 2018). The primary aim of the current study was to compare the content of these scales regarding the extent to which they

assess different elements of body checking. The analyses relating to this aim were conducted separately for two different types of content. First, elements that related to physique self-monitoring techniques and related constructs (e.g., comparison to reference values) were appraised. Second, regarding the other important aspect of the physique self-monitoring definition, the specific focuses of the self-monitoring techniques and comparisons were also considered (e.g., aspects of the shape, size or weight of one's body). Due to the content of measurement instruments having implications for evidence synthesis, a secondary aim of this study was to compare the assessment of body checking across the two reviews (Nikodijevic et al., 2018; Walker et al., 2018). Specifically, this study aimed to identify variation in the assessed body checking constructs that arose from the reviews including different studies. By focusing on the overall constructs assessed by the reviews, the current study further aimed to exemplify the neglect of construct validity in the area of eating and exercise psychopathology, as well as highlighting how its neglect in individual studies can have consequences for evidence synthesis.

2.2.1. Methods

Identification and extraction of sets of body checking items

Body checking scales were identified by consulting two published reviews regarding body checking and body avoidance (Nikodijevic et al., 2018; Walker et al., 2018). First, each review's study selection criteria were summarised. Second, each review's tabulated summaries of its included studies were reviewed to identify: published studies in English that assessed body checking; and the self-report scales, subscales or items that these studies used to assess body checking. Third, the methods section of each published study was reviewed to extract data about the application of its body checking scales, subscales or items (e.g., number of items, alterations to instrument). Fourth, a list was compiled of all the unique sets of items used to assess body checking in the studies. From this point onward, the term 'item-set' is used instead of 'scale' or 'subscale'. This terminology reflects the identification of studies that ostensibly used the same instruments, but varied in terms of the actual items that participants were asked to complete (i.e., items were removed from or added to existing instruments). As the alteration of a scale or subscale's items affects the

content and properties of the instrument (e.g., Furr, 2011), it was deemed important to group any such alteration as representing a unique item-set. Last, following the identification of all unique item-sets, all items (excluding instructions and response scales) comprising these sets were extracted from the original article detailing their development. If the items were not reported in the original article or its supplementary material, the respective authors were contacted to obtain the items. All authors provided these items upon request.

Item-coding

In order to identify the constructs assessed by each item, two separate coding frameworks were developed and refined relating to: 1) Behaviours and Cognitions; and 2) Body-Related Focuses. Both coding frameworks are provided in the Appendices (A and B, respectively).

The first coding framework (Behaviours and Cognitions) comprises seven codes, and each body checking item is coded with one of these. Code A is applied to items that assess the performance of a self-monitoring technique without explicit comparison to a reference value (e.g., 'I look at my body in the mirror'). Three codes correspond to items that assess the performance of a comparison in relation to one of three types of reference value (cf. Harkin et al., 2016): B) past states (e.g., 'I compare my body to three years ago'); C) other people (e.g., 'I compare my body to my friends'); and D) desired (future) states (e.g., 'I compare my body to my target weight'). The three remaining codes relate to: E) the elicitation of feedback from other people (e.g., 'I ask people to tell me what my body is like'); F) a cognition (e.g., 'I do not like my body'); and G) monitoring a focus other than one's current state (e.g., 'I monitor the temperature of my house'). In contrast to Fried's purely inductive approach (2017), codes A, B, C and D were deductively generated (i.e., derived from theory outlined in subsection 2.1.3.). The remaining codes (E, F and G) were generated inductively by creating codes when relevant content in an item was not captured by the four theoretical codes.

The second coding framework (Body-Related Focuses) comprises 24 codes that relate to four main categories: 1) parts of the body (e.g., 'hips', 'thighs', 'stomach'; 14

codes); 2) composition of the body (e.g., 'fat', 'muscle'; 8 codes); 3) appearance (1 code); and 4) no explicit body-related focus (1 code). This coding framework is only applied to items assessing the performance of a self-monitoring technique or comparison (i.e., codes A, B, C or D in the Behaviours and Cognitions framework). A code is selected if the specific aspect of the body is represented in an item as the focus of a self-monitoring technique or comparison. Therefore, more than one Body-Related Focuses code might relate to each body checking item. All codes comprising the Body-Related Focuses coding framework were inductively generated.

Two raters applied both coding frameworks separately to the pooled items comprising the item-sets (presented in a randomised order without any information about their item-set of origin). After applying the Behaviours and Cognitions framework, the degree of interrater agreement was calculated (Cohen's kappa coefficient; Cohen, 1960). Any discrepancies in the application of the coding frameworks were then resolved through discussion. As multiple codes within the Body-Related Focuses coding framework could be applied to each body checking item, Cohen's kappa coefficient was not calculated for the second coding framework, and discrepancies were resolved through discussion.

Data analysis

Regarding the two coding frameworks, each item-set was summarised based on the percentage of its items that were rated with each code. When summarising the item-sets using the Body-Related Focuses framework, item-sets were excluded that did not include any items that assessed the performance of self-monitoring techniques or comparisons (i.e., codes A, B, C or D on the Behaviours and Cognitions coding framework).

The overall body checking constructs assessed in each review were then approximated by recalculating the percentages of items corresponding to each code across all studies in the review. When compiling the complete list of items for each review, each unique item was included a number of times equal to the number of studies in which it featured (e.g., an item was included three times if it featured in three studies). The overall body checking construct for each review should be

interpreted clearly as an approximation, as it does not take into account weightings for a study's sample size. Sample size was not controlled for across the studies to facilitate comparison across the reviews, as the reviews often differed in terms of the samples of interest within each study (e.g., clinical and/or non-clinical samples).

2.2.2. Results

Study selection criteria used in reviews

Both reviews (Nikodijevic et al., 2018; Walker et al., 2018) included published and unpublished studies – limited to studies written in English in Nikodijevic and colleagues' review – that contained a measure of "[body checking] behavior" (p747; Walker et al., 2018), or "body checking" (p161; Nikodijevic et al., 2018). Walker and colleagues included studies that correlated body checking with "[eating disorder] pathology, body image dissatisfaction, or mood/affect" (p747). In contrast, Nikodijevic and colleagues included studies that assessed body checking, and "measured [eating disorder] pathology, or separated groups by [eating disorder] status/diagnosis" (p161). For the reviews' meta-analyses, studies were excluded if effects sizes (or sufficient data to calculate these) were not provided. Last, Nikodijevic and colleagues also excluded: 1) single-item measures of body checking or eating disorder pathology, as they were deemed "inadequate measure[s] of the construct" (p161); 2) ecological momentary assessment designs, "as the review focused on trait-level relationships" (p161); 3) experimental and prospective studies that did not include a baseline measure of body checking; and 4) studies in the meta-analysis that included an eating disorder sample without a control group.

Published studies assessing body checking included in reviews

Walker and colleagues (2018) included 26 published studies assessing body checking in their review, compared to Nikodijevic and colleagues (2018) including 40. Overall, 54 published studies were included across the two reviews, and 12 (22%) of these were included in both reviews (i.e., small overlap in the research that the reviews examined). A summary of each study's assessment of body checking is presented in Appendix C.

Body checking item-sets

Item-sets and their use in reviews' published studies

In total, 12 unique body checking item-sets that were included in the published studies as a measure of body checking were identified. As shown in Table 2, the (original, unaltered) BCQ (Body Checking Questionnaire; Reas et al., 2002) was the most commonly used item-set, featuring in 59% (32/54) of the published studies. Four item-sets represent scales (*BCAQ(2004)*, *BCCS*, *BCQ*, *MBCQ*), 4 represent subscales (*BCAQ(2017):Checking*, *BRBS:Checking*, *BSBS:Checking*, *OBCS:BS*), and 4 represent alterations to scales or subscales (*BC-EMA*, *BCQ(+5)*, *BSQ:Item30*, *OBCS:BS(-1)*).

Table 2. Summary of body checking item-sets

Identifier	Name	Reference	Number of items	Published studies in reviews using item-set***		
				Walker et al. (2018); 26 studies	Nikodijevic et al. (2018); 40 studies	Both; 54 studies
BC-EMA	Body Checking Ecological Momentary Assessment	Engel et al. (2005)	2	1 (4%)	-	1 (2%)
BCAQ(2004)	Body Checking and Avoidance Questionnaire (2004)	Shafran, Fairburn, Robinson, and Lask (2004)	22*	-	3 (8%)	3 (6%)
BCAQ(2017):Checking	Body Checking and Avoidance Questionnaire (2017): Checking subscale	Legenbauer et al. (2017)	12	1 (4%)	1 (3%)	1 (2%)
BCCS	Body Checking Cognitions Scale	Mountford, Haase, and Waller (2006)	19	-	1 (3%)	1 (2%)
BCQ	Body Checking Questionnaire	Reas et al. (2002)	23	11 (42%)	29 (73%)	32 (59%)
BCQ(+5)	Body Checking Questionnaire +5 items	Alperin, Hornsey, Hayward, Diedrichs, and Barlow (2014)	28	-	1 (3%)	1 (2%)
BRBS:Checking	Body-Related Behaviours Scale: Checking subscale	Meyer, McPartlan, Rawlinson, Bunting, and Waller (2011)	9	2 (8%)	2 (5%)	2 (4%)

BSBS:Checking	Brief Safety Behaviours Scale: Checking subscale	Bohn, Brown, Farquharson, and Tata (2009)	4	1 (4%)	-	1 (2%)
BSQ:Item30	Body Shape Questionnaire: Item 30	Cooper, Taylor, Cooper, and Fairburn (1987)	1	3 (12%)	-	3 (6%)
MBCQ	Male-Specific Body Checking Questionnaire	Hildebrandt, Walker, Alfano, Delinsky, and Bannon (2010)	19**	1 (4%)	3 (8%)	3 (6%)
OBCS:BS	Objectified Body Consciousness Scale: Body Surveillance subscale	McKinley and Hyde (1996)	8	5 (19%)	-	5 (9%)
OBCS:BS(-1)	Objectified Body Consciousness Scale: Body Surveillance subscale -1 item	Fitzsimmons-Craft, Harney, et al. (2012)	7	1 (4%)	-	1 (2%)

*Excludes open-response item

**Alternative 16-item version detailed in reference, 19-item scale used for item-set

***Values represent the number and percentage of studies in each review that used the item-set

Behaviours and cognitions in item-sets

A very high level of interrater agreement for the application of the Behaviours and Cognitions coding framework (unweighted κ = .85) was observed. Figure 1 presents the percentage of items in each item-set that were rated with each code in the Behaviours and Cognitions coding framework. As each item is only assigned one code in this framework, each item-set's percentages total 100.

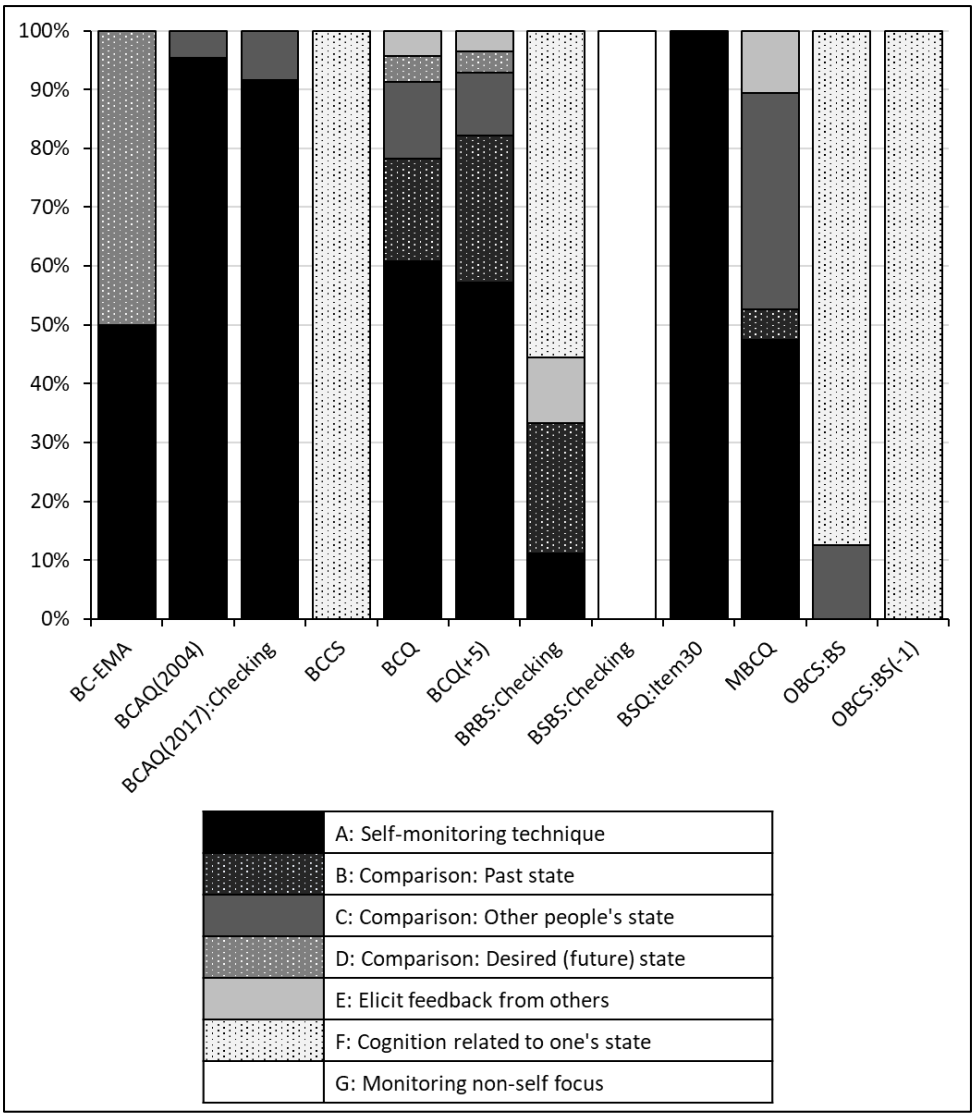

Figure 1. Percentage of items in each item-set corresponding to Behaviours and Cognitions codes.

As shown in Figure 1, the item-sets contained a large degree of heterogeneity regarding the constructs that they assess. The three most pure measures of self-monitoring techniques were *BSQ:Item30* (100%, 1/1 item), *BCAQ(2004)* (95%, 21/22 items) and *BCAQ(2017):Checking* (92%, 11/12 items). Approximately half of the items comprising four item-sets assessed self-monitoring techniques: *BCQ* (61%, 14/23 items), *BCQ(+5)* (57%, 16/28 items), *BC-EMA* (50%, 1/2 items), and *MBCQ* (47%, 9/19 items). Between 35% and 50% of items comprising four item-sets assessed comparisons (i.e., codes B, C or D): *BC-EMA* (50%, 1/2 items), *MBCQ* (42%, 8/19 items), *BCQ(+5)* (39%, 11/28 items), and *BCQ* (35%, 8/23 items). Two item-sets only assessed cognitions related to one's state (*BCCS*, 100%, 19/19 items; *OBCS:BS(-1)*, 100%, 7/7 items), while a large percentage of items in two other item-sets also assessed cognitions (*OBCS:BS*, 88%, 7/8 items; *BRBS:Checking*, 56%, 5/9 items). Last, all items (100%, 4/4 items) on *BSBS:Checking* assessed the monitoring of a focus other than oneself, and therefore the item-set is unrelated to body checking (e.g., "Double-check water taps to make sure they are turned off"; Waller & Marcoulides, 2013).

Body-related focuses in item-sets

For these analyses, all items within the item-sets assessing a self-monitoring technique or comparison (i.e., Behaviours and Cognitions codes A, B, C or D) were coded using the Body-Related Focuses framework. Consequently, the percentage of items included in these analyses from each item-set are as follows: *BC-EMA*, 100% (2/2 items); *BCAQ(2004)*, 100% (22/22 items); *BCAQ(2017):Checking*, 100% (12/12 items); *BCQ*, 96% (22/23 items); *BCQ(+5)*, 96% (27/28 items); *BRBS:Checking*, 33% (3/9 items); *BSQ:Item30*, 100% (1/1 item); *MBCQ*, 89% (17/19 items); and *OBCS:BS*, 13% (1/8 items). Three item-sets were excluded from these analyses, as they did not include any items that assess the performance of self-monitoring techniques or comparisons (*BCCS*, *BSBS:Checking*, *OCBS:BS(-1)*). Figure 2 presents a heatmap of the percentages of items corresponding to each Body-Related Focuses code in each included item-set (empty cells represent 0% values).

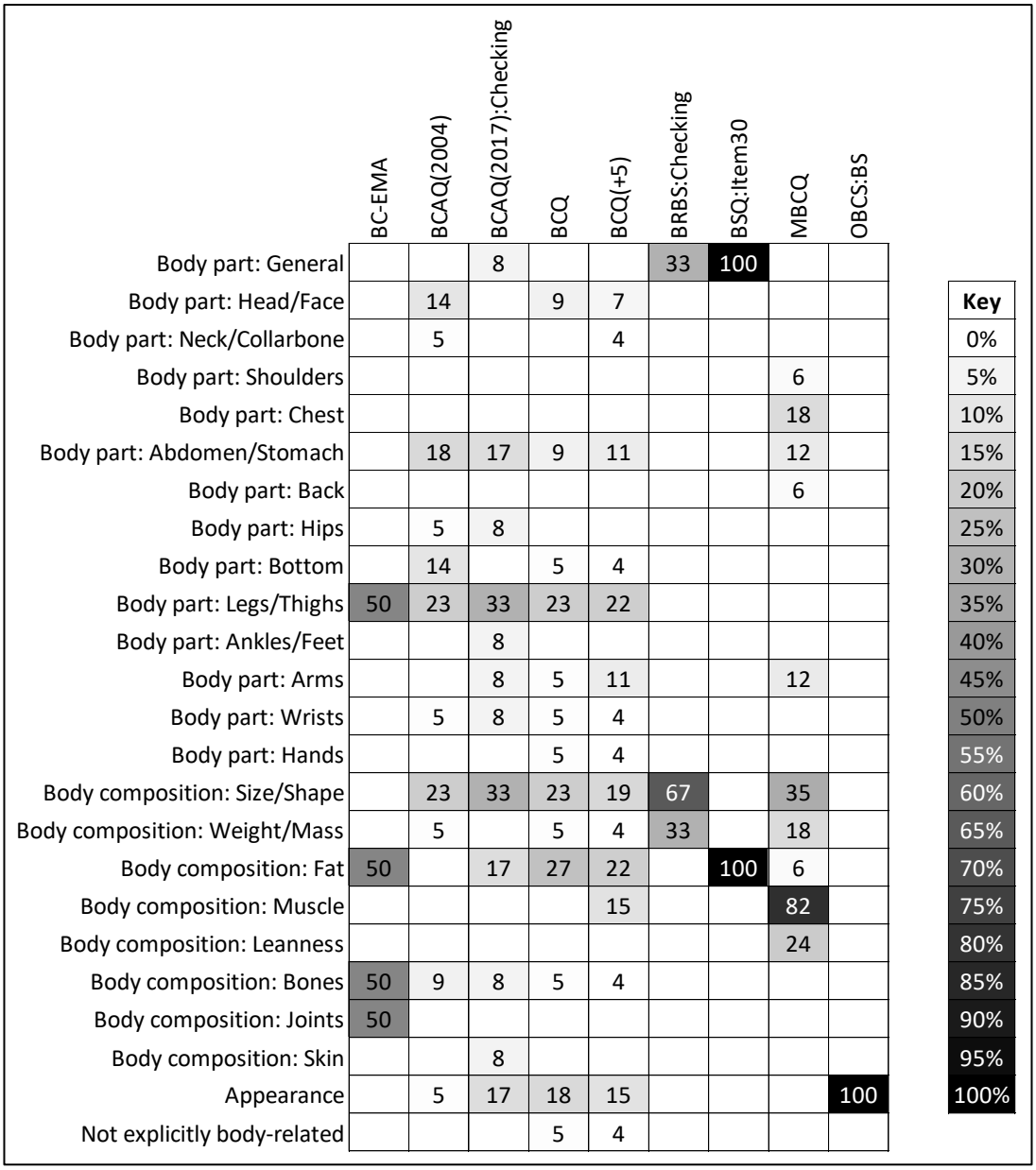

Figure 2. Percentage of items in each item-set corresponding to Body-Related Focuses codes.

As indicated in Figure 2, in addition to the heterogeneity regarding the assessed behaviours and cognitions, the items also varied greatly in terms of their body-related focuses. In five item-sets (*BC-EMA*, *BCAQ(2004)*, *(BCAQ(2017):Checking*, *BCQ*, *BCQ(+5)*), legs or thighs were the most common body parts on which the assessed self-monitoring techniques and comparisons focused. The abdomen or stomach, were also commonly assessed body-related focuses. Regarding body composition, items that focused on fat, and the size or shape of one's body were most common.

The *MBCQ* differed from the other item-sets, as it focused more on muscle than fat. Five item-sets (*BCAQ(2004)*, *BCAQ(2017):Checking*, *BCQ*, *BCQ(+5)*, *OBCS:BS*) contained items that assessed the performance of self-monitoring techniques or comparison with a focus on one's appearance, with this representing the sole focus of the *OBCS:BS*. Last, one item that featured in both the *BCQ* and *BCQ(+5)* item-sets was judged as not explicitly body-related (i.e., "I compare myself to models on TV or in magazines").

Summary of overall constructs assessed by each review

Behaviours and cognitions in reviews

Figure 3 presents the percentage of each review's included items (weighted by the frequency with which the item-sets of origin were included) that corresponded to each Behaviours and Cognitions code.

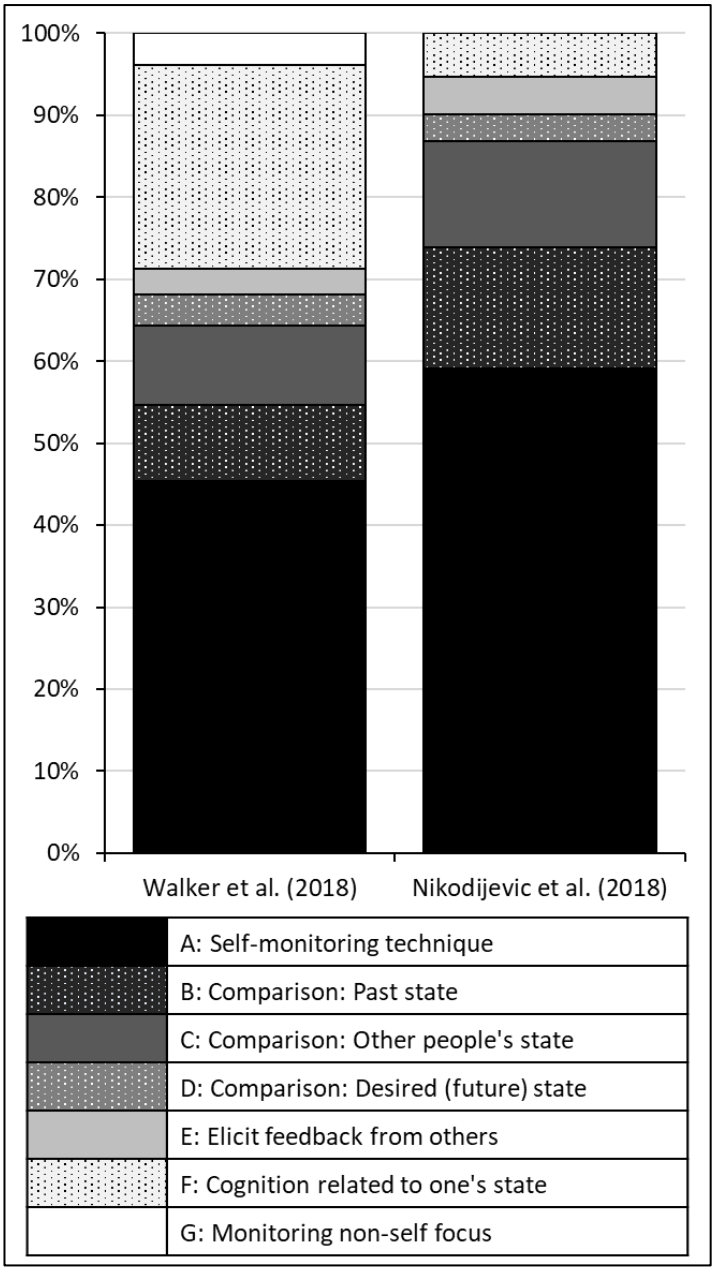

Figure 3. Percentage of items in each review corresponding to Behaviours and Cognitions codes.

As shown in Figure 3, the reviews differed in terms of the overall body checking constructs that they assessed. The assessment of the performance of a self-monitoring technique represented the largest proportion of both reviews' body checking constructs, with 45% of items assessing this in Walker et al.'s review (2018), and 59% in Nikodijevic et al.'s review (2018). The performance of a comparison also comprised large proportions of the reviews' constructs. Respectively, 23% and 31%

of items comprising Walker et al.'s and Nikodijevic et al.'s reviews assessed the performance of a comparison (i.e., using either the past, other people or a target as reference values). Other aspects of the body checking constructs related to the elicitation of feedback from others (3% and 5% for Walker et al. and Nikodijevic et al., respectively), and cognitions (25% and 5% for Walker et al. and Nikodijevic et al., respectively). Last, 4% of Walker et al.'s construct was associated with monitoring a focus other than oneself. Overall, Nikodijevic et al.'s body checking construct was more associated with self-monitoring techniques and comparisons than Walker et al.'s construct (90% and 68% of the body checking constructs, respectively).

Body-related focuses in reviews

Figure 4 presents the percentage of each review's included items assessing a self-monitoring technique or comparison (weighted by the frequency with which the item-sets of origin were included) that corresponded to each Body-Related Focuses code. The codes are ordered in terms of the Body-Related Focuses category ('body part', 'body composition', 'appearance', 'not explicitly body-related'), and then in descending order of the percentage difference between the reviews.

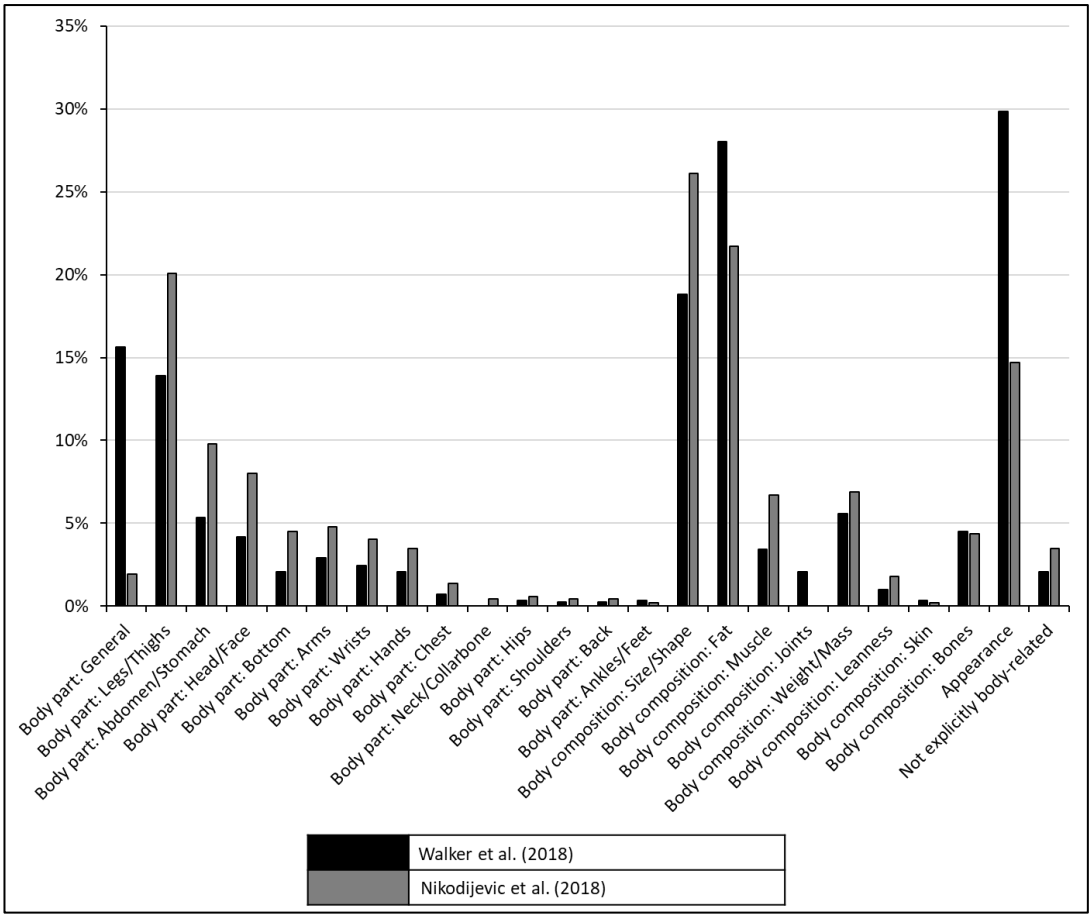

Figure 4. Percentage of items in each review corresponding to Body-Related Focuses codes.

As shown in Figure 4, in addition to the reviews' body checking constructs varying in terms of the Behaviours and Cognitions codes, the constructs also differed in terms of their body-related focuses. Regarding parts of the body, Walker et al.'s construct had a 14% greater focus on *general* body parts (i.e., items that were body-related, but did not specify the part that one monitors or compares) than Nikodijevic et al.'s construct. Accordingly, a ≥1% greater focus on *specific* body parts was observed in Nikodijevic et al.'s construct compared to Walker et al. (legs/thighs, 6% difference; abdomen/stomach, 4% difference; head/face, 4% difference; bottom, 2% difference; arms, 2% difference; wrists, 2% difference; hands, 1% difference). Regarding ≥1% greater differences in body composition, Nikodijevic et al.'s construct focused more on body size/shape (7% difference), muscle (3% difference), and weight/mass (1% difference). In contrast, Walker et al.'s construct focused more on fat (6% difference)

and joints (2% difference). Last, the largest difference between the reviews was that Walker et al.'s body checking construct had a 15% greater focus on appearance than Nikodijevic et al.'s construct.

2.2.3. Discussion

In the study reported in this section, 12 sets of body checking self-report items (i.e., item-sets) were identified that were used in studies included in two reviews (Nikodijevic et al., 2018; Walker et al., 2018). In line with its primary aim, this study compared two aspects of the content (i.e., items) comprising these item-sets. First, the item-sets were found to differ substantially in terms of the degree to which they assessed self-monitoring techniques (e.g., looking in the mirror, pinching parts of one's body) and related constructs (e.g., comparisons to reference values). Second, heterogeneity in the scales' content was also observed in their assessment of body-related focuses (i.e., aspects of one's body) of the self-monitoring techniques and comparisons. Addressing a secondary aim, the two reviews were also found to vary considerably in the overall body checking construct that they assessed.

Body checking item-sets

Regarding the 12 body checking item-sets, the content of these varied considerably in terms of whether they assessed self-monitoring techniques, comparisons or other constructs. Indeed, while almost all (or all) of the content of some item-sets assessed self-monitoring techniques (i.e., *BCAQ(2004)*, *BCAQ(2017):Checking*, *BSQ:Item30*), other item-sets contained no content specific to these techniques (i.e., *BCCS*, *BSBS:Checking*, *OBCS:BS*, *OBCS:BS(-1)*). Consequently, the identified item-sets vary greatly in their appropriateness for assessing body checking, as defined in the two reviews (i.e., behaviours that assess or check aspects of one's body; Nikodijevic et al., 2018; Walker et al., 2018). A complicating factor is that some item-sets (e.g., *BCQ*, *BCQ(+5), MBCQ*, *BC-EMA*) comprise large proportions of content that assess comparisons to reference values (i.e., past states, other people, desired future states; cf. Harkin et al., 2016). As self-monitoring techniques are implicit within comparisons (i.e., a person must necessarily assess their current state to compare it to a reference value), items that assess comparisons prevent specific conclusions from being made

about self-monitoring techniques and reference values, as both constructs influence the resulting score (cf. McGrath, 2005). Indeed, the inability to make specific conclusions reflects the rationale behind the conceptualisation of physique self-monitoring, which, compared to body checking, explicitly distinguishes between self-monitoring techniques and comparisons to reference values.

While self-monitoring techniques and comparisons to reference values represented deductively generated codes, content within the item-sets was identified that required the generation of three additional codes. First, one item in *BCQ*, *BCQ(+5)* and *BRBS:Checking*, and two items in *MBCQ* assessed the elicitation of feedback from others (e.g., BCQ item 7, "I try to elicit comments from others about how fat I am"; Reas et al., 2002). While eliciting feedback from others is arguably a method of assessing one's current state, structural validity evidence in the development of the Body Checking and Avoidance Questionnaire (BCAQ; Legenbauer et al., 2017) suggests that such techniques should be considered separately. Specifically, the BCAQ was found to comprise three independent factors, including one relating primarily to self-monitoring techniques (i.e., *BCAQ(2017):Checking*), and another that related to 'reassurance seeking' (e.g., "I ask my partner or friends whether I have gained weight or should go on another diet"). As reassurance seeking ostensibly reflects the elicitation of feedback from others, the separate factors identified by Legenbauer and colleagues indicate that this construct should not be considered a self-monitoring technique. Second, the majority of content in four item-sets (*BCCS*, *BRBS:Checking*, *OBCS:BS*, *OBCS:BS(-1)*) assessed cognitions that related to one's body. Indeed, this is unsurprising, as the purpose of the scales corresponding to these item-sets was to assess, at least partly, the cognitions relating to body checking (Meyer et al., 2011; Mountford et al., 2006) or 'body surveillance' (McKinley & Hyde, 1996). Third, the content comprising *BSBS:Checking* had no relation to body checking-related constructs, but instead concerned checking, for example, whether the water and gas are turned off. As with the previous point, this is unsurprising, as the scale was developed for the purpose of assessing "overt safety behaviours, as seen typically in anxiety disorders" (Waller & Marcoulides, 2013, p258).

Regarding the body-related focuses of self-monitoring techniques and comparisons to reference values, the item-sets broadly differed regarding whether their items referred to the body in general (e.g., BRBS:Checking item 7, "Checking my body [...]"; Meyer et al., 2011), or specific body parts (e.g., thighs, stomach). The tendency of the item-sets to focus on specific body parts likely reflects that patients with clinical eating disorders are suggested to monitor different body parts than non-clinical samples (e.g., Shafran et al., 2004). In relation to one's body composition, most item-sets assessed one's checking of their size and/or shape, and fat. However, an exception was a focus on checking one's muscle in the *MBCQ*, which was developed to assess 'male-specific' body checking (Male-Specific Body Checking Questionnaire; Hildebrandt et al., 2010). Indeed, only one other item-set (*BCQ(+5)*) contained muscle-focused items, which were added to the BCQ to make the scale more 'gender-inclusive' (Alperin et al., 2014). Consequently, both item-sets highlight the importance of considering how body checking is assessed with regard to gender, although further consideration of this complex issue is outside the scope of this thesis.

Compared to the monitoring of one's size and/or shape, few items explicitly referenced the self-monitoring of weight. This was surprising given the emphasis on assessing one's weight in definitions of body checking (Nikodijevic et al., 2018; Walker et al., 2018), and the well supported effect of frequent self-weighing on weight-loss and, to a lesser extent, eating psychopathology (e.g., Benn et al., 2016). In contrast, the appearance of one's body was commonly referenced. While appearance can be considered to subsume the size and/or shape of one's body, it also ostensibly relates to one's *cosmetic* appearance (e.g., clothing, grooming). Consequently, the tendency to include cosmetic appearance in, and omit weight from these measures could potentially underestimate relationships between body checking and behaviours that impact one's physique, which are core aspects of eating psychopathology (e.g., dieting, compulsive exercise; e.g., Pennesi & Wade, 2016). Within the definition of physique self-monitoring, greater specificity might therefore be advantageous, such as adding the following italicised text: "(i.e., the shape, size and weight of their body*, but excluding cosmetic appearance*)". More generally, the

term ‘appearance’ should arguably be avoided in item-wording to avoid such imprecision.

Synthesis of body checking evidence

The item-sets reviewed above were selected on the basis of being used in studies included in two reviews of body checking research (Nikodijevic et al., 2018; Walker et al., 2018). Accordingly, the suitability of these item-sets for assessing body checking was judged by the reviews’ authors, rather than the developers of the items, or the authors of the individual studies. However, the heterogeneity in the item-sets indicates that the content was insufficiently considered by the reviewers. Indeed, some of the studies appear to have been selected for inclusion in the reviews based on the name of the measure (cf. jingle fallacy; Thorndike, 1904). Taking the most extreme example, the content of *BSBS:Checking* had no relation to one’s body, instead focusing on aspects such as checking that water taps are turned off. In the study that used *BSBS:Checking* (Waller & Marcoulides, 2013), the item-set is referred to as the ‘Checking subscale’, with no suggestion that its content relates to one’s body. However, as the study concerned eating disorders, a plausible reason for the study’s inclusion in a review could be the mistaken assumption that the ‘Checking’ scale assessed *body* checking (i.e., being selected based on its name). While *BSBS:Checking* represents an extreme example, studies (and, therefore, item-sets) were also included in the reviews that aimed to assess body checking-related cognitions rather than self-monitoring techniques. Given the reviews’ definitions of body checking as a behaviour, the inclusion of studies assessing cognitions further suggests insufficient consideration of the content of items-sets. As a consequence, the reviews’ conclusions about body checking *behaviours* are inaccurate, and should also acknowledge cognitions and other assessed constructs. This is particularly important, as an estimated 25% of Walker and colleagues’ overall body checking construct related to cognitions (and 5% of Nikodijevic and colleagues’ overall construct).

In addition to the inclusion of irrelevant studies in the reviews, highly relevant literature was also omitted. For example, item-sets with content relating to comparisons and one’s appearance were common in both reviews. Consequently, it

can be argued that literature relating to physical appearance comparisons should also be included. Indeed, the commonly used Physical Appearance Comparison Scale (Thompson, Heinberg, & Tantleff-Dunn, 1991) contains content relating to comparing one's body shape, size, weight, fat and appearance to other people. However, it is likely that studies using this scale were not identified due to the search strategy of both reviews relying on the single phrase 'body checking'. In other words, by not focusing on the substantive nature of constructs, the reliance on a single term or phrase prevented the identification of highly relevant studies that investigated a nominally different construct (cf. jangle fallacy; Kelley, 1927).

Implications

The consequences of neglecting the appropriateness of a measure's content are easily avoidable. Specifically, having a clear conceptualisation of one's construct of interest and considering how a study, measure or manipulation relates to this (cf. Flake & Fried, 2019) would have avoided many of the problems highlighted in this section. However, this has specific challenges for evidence synthesis and measurement instruments.

Regarding evidence synthesis, as mentioned, both reviews committed the jingle fallacy (Thorndike, 1904) by using narrow search terms to identify relevant literature. Similarly, the study reported in this section also committed this fallacy by including these two reviews based on their focus on 'body checking', and therefore reviews of nominally different constructs were not considered (e.g., physical appearance comparisons; e.g., Myers & Crowther, 2009). However, this issue is not uncommon, and the reason for this is likely practical in nature. Specifically, as the scientific literature grows, it becomes increasingly challenging to identify and synthesise all relevant evidence (e.g., Michie et al., 2017). As this represents an issue affecting academia as a whole, there is a trade-off for individual researchers between conducting reviews that are sufficiently broad and practically achievable. However, if sufficiently broad reviews are not practically achievable, the position of reviews and meta-analyses at the top of the hierarchy of evidence (Murad et al., 2016) should be considered critically.

Concerning measurement instruments, this study demonstrated that the selection of a measure whose content aligns with the definition of a target construct is highly important (Flake & Fried, 2019). For example, if assessing physique self-monitoring, *BCAQ(2004)* appears to be the most appropriate existing item-set in terms of its content, as it primarily assesses self-monitoring techniques (i.e., not comparisons to reference values) and comprises minimal content relating to appearance. However, if assessing a person's *comparison* of their physique, *BCAQ(2004)* would be less suitable. Due to item-level analyses (e.g., network analysis) becoming increasingly popular, individual items should also be considered in terms of their content. As argued by Clark and Watson (1995), the shorter and simpler items are, the less likely they are to relate to unintended constructs. However, as shown in this study, large proportions of items in body checking scales assess comparisons, which capture constructs concerning self-monitoring techniques and reference values. While the effect of heterogeneity in a scale can be partially addressed by examining item-level relationships, heterogeneity within an item cannot be addressed. As such, it is vital that items are as elemental as possible. Last, when selecting a measurement instrument, researchers should also consider how its content relates to other constructs of interest. For example, in a previously detailed study framed within control theory (Dalley et al., 2019), a relationship between body checking (i.e., a self-monitoring technique) and a 'thin-ideal' goal (i.e., a reference value) was assessed. However, body checking was assessed with the *BCQ* item-set, of which 35% of the items were found to assess comparisons to reference values. The positive association observed by Dalley and colleagues between body checking and a 'thin-ideal' goal is therefore potentially overestimated, as the assessed constructs overlap. As such, it is important that the measurement tools used in studies distinguish between the focal constructs, otherwise a statistical correlation might simply represent an overlap in the instruments' content (Maul, 2017).

Limitations

A limitation of the current approach is that other researchers might not consider the distinctions made in the coding frameworks to be appropriate. Indeed, researchers with alternative theoretical perspectives might make different distinctions regarding

the constructs present within the item-sets' content. Such a limitation cannot be avoided, and it is partly for this reason that the selection of the current study's theoretical approach (i.e., control theory; Carver & Scheier, 1982) was detailed and justified in the previous section. Furthermore, some distinctions might be considered too elemental (e.g., separately coding comparisons to different types of reference value), and could be viewed as exaggerating the heterogeneity in the item-sets. However, the more precise approach taken in this study was deemed advantageous, as this permits readers to group the more specific codes together as desired. Another limitation to this study's approach is that only published studies included in the two reviews were considered for the current analyses. This criterion was applied as it was important to be able to identify the aim of the original studies and item-sets. However, as a result, the overall constructs assessed by the reviews should be viewed as approximations.

Future directions

One of the clearest future directions for this line of enquiry is to conduct similar research investigating the content of other measurement instruments. In the area of eating psychopathology there are several important constructs, with each subsuming different variables (Pennesi & Wade, 2016). For each variable, there are likely to be several commonly used measures, which potentially vary in terms of their content and the constructs they assess. Indeed, depression is stated as an important variable in relation to eating psychopathology, with measures of depression having been demonstrated to vary greatly in terms of their content (Fried, 2017). Consequently, appraising the content of existing measures would facilitate the instruments being used more precisely, and could therefore help researchers to avoid committing the jingle fallacy (i.e., selecting a measure based solely on its name; Thorndike, 1904), which could lead to other benefits (e.g., facilitating the synthesis of evidence).

Regarding body checking research, future directions are less clear and depend on one's theoretical perspective. For example, if a researcher considers the commonly used *BCQ* item-set to align perfectly with the body checking construct, there is little reason to adopt a different measure, or change one's conceptualisation. However, as has been demonstrated in this study, the current body checking construct appears

to contain substantial heterogeneity within it. As argued, a way in which to address this heterogeneity is to conduct research into more elemental aspects of body checking, such as physique self-monitoring. However, such research would require the use of measures whose content aligns with the construct definition (e.g., assessing self-monitoring techniques without assessing reference values). Consequently, the first step in research into physique self-monitoring would be to develop an appropriate measurement instrument.

Conclusion

Together with the previous section, the current study exemplified how the conceptualisation of a construct, and the content validity of associated measurement instruments are often neglected. As demonstrated, a neglect of these issues can lead to problems in synthesising evidence (e.g., the inclusion of irrelevant research), which could potentially influence clinical decisions based on the findings of reviews or meta-analyses. While the examination of construct validity in this section has focused on body checking, the issues raised are equally important to other existing eating and exercise-related constructs. Indeed, as body checking represents a form of monitoring, the issues outlined in the current chapter can inform the broad aim of this thesis, which is to conceptualise physical activity self-monitoring in relation to eating psychopathology and compulsive exercise. The specific aims of this thesis are outlined in the next chapter, as well as the rationale and methodology for addressing these aims.

3. Pathological physical activity self-monitoring:

Development of a novel construct

3.1. Behavioural self-monitoring, and eating and exercise psychopathology

The previous chapter reported a critical appraisal of body checking, and presented a more elemental and precise construct, physique self-monitoring. Compared to body checking, physique self-monitoring was situated within control theory (Carver & Scheier, 1982), and is more explicitly distinguished from related constructs (e.g., comparisons to reference values). Reflecting a previously outlined distinction, physique self-monitoring represents the monitoring of a behavioural outcome (e.g., body weight; Michie et al., 2015). However, self-monitoring a behavioural focus (e.g., eating, exercise) has been to shown to have a more reliable effect on behaviours than on their associated outcomes (Harkin et al., 2016). Consequently, an understanding of self-monitoring one's behaviour in relation to eating and exercise psychopathology is crucial, and is the central aim of this thesis. Therefore, following an overview of existing research into self-monitoring one's behaviour in the area of eating and exercise psychopathology, the specific aims of this thesis (section 3.2.) and its overall methodological approach (section 3.3.) are outlined.

3.1.1. Behavioural self-monitoring in interventions

In the previously detailed application of a behaviour change technique taxonomy to five eating disorder treatment manuals (Leonidas et al., 2019), techniques that prompt patients to self-monitor were found to feature less in the manuals than other techniques (e.g., providing information on consequences of behaviour). However, while prompting self-monitoring of a behavioural outcome appeared in two manuals, prompting self-monitoring of a behaviour appeared in three. Cognitive Behavioural Therapy-Enhanced (CBT-E; Fairburn, 2008) particularly emphasises the criticality of behavioural self-monitoring, informing patients that it "is as important as attending [the] sessions" (p. 57). Specifically, patients participating in CBT-E are asked to record all food and drink intake, as well as binge eating episodes, vomiting, and use of laxatives and diuretics. The patients are also asked to report the context and their feelings related to these behaviours. CBT-E considers behavioural self-monitoring to be important as it enables both the patient and therapist to understand the problem,

and facilitates the development of less problematic behaviours (Fairburn, 2008). Indeed, such behavioural self-monitoring has been found to reduce the frequency of binge-eating episodes in patients with bulimia nervosa and binge-eating disorder (Hildebrandt & Latner, 2006; Latner & Wilson, 2002).

While CBT-E recommends using paper sheets for recording the above information, mobile apps that might facilitate similar behavioural self-monitoring have since been developed specifically for people with eating disorders (e.g., Fairburn & Rothwell, 2015; Juarascio, Manasse, Goldstein, Forman, & Butryn, 2015; Tregarthen, Lock, & Darcy, 2015). However, while self-monitoring using these apps might be simpler (e.g., Juarascio et al., 2015), patients' preferences for the form of self-monitoring must still be considered. Specifically, some eating disorder patients have viewed use of these apps as detrimental to their recovery (Lindgreen, Lomborg, & Clausen, 2018). As use of one's preferred form of self-monitoring has been found to result in higher adherence to the self-monitoring (Shay et al., 2009), it is therefore likely that allowing patients to use the form they prefer will lead to greater adherence to CBT-E interventions.

3.1.2. Behavioural self-monitoring using technology

While mobile apps have been developed to support eating disorder recovery, a small-scale study reported that there is little awareness of these in the population who might benefit from using them (Eikey, Chen, & Zheng, 2019). Specifically, 17 of the 24 young, female participants with either self- or clinically-diagnosed eating disorders were not aware of the apps, despite 20 of them identifying as being in recovery. While these recovery-focused apps might not be well known, and might consequently be underused, there is growing concern about people with and at-risk of eating disorders using commercially available mobile apps and devices related to weight, diet and physical activity (e.g., Fairburn & Rothwell, 2015; Honary, Bell, Clinch, Wild, & McNaney, 2019). These technologies vary considerably in terms of their focuses (i.e., weight, diet and/or physical activity), as well as the behaviour change techniques they include (e.g., goal-setting, providing instructions; e.g., Direito et al., 2014). However, the previously discussed taxonomic analyses (e.g., Michie et al., 2013) typically indicate that behavioural self-monitoring (e.g., tracking diet or

physical activity) is particularly common across these apps and devices (e.g., Conroy et al., 2014; Direito et al., 2014; Lyons et al., 2014; Mercer et al., 2016; Middelweerd et al., 2014). Therefore, the general terms 'diet tracker' and 'fitness tracker' will be used when referring to a commercial device or mobile app that facilitates the self-monitoring of diet or physical activity, respectively.

Cross-sectional survey evidence

Reflecting concern about the use of diet and fitness trackers in relation to eating and exercise pathology, several studies have been conducted that aim to address this issue. To date, these studies have been predominantly cross-sectional surveys, which involve asking participants to self-report their use of, or attitudes towards, diet and/or fitness trackers. For instance, of 55 female patients with clinical eating disorders, more viewed diet, fitness and/or weight trackers as maintaining their condition (*n*=6), than aiding their recovery (*n*=3; Tan, Kuek, Goh, Lee, & Kwok, 2016).

Several other cross-sectional survey-based studies in community samples have quantitatively assessed the association between diet and fitness tracker use, and eating and exercise pathology (Embacher Martin, McGloin, & Atkin, 2018; Hefner et al., 2016; Plateau et al., 2018; Sarcona, Kovacs, Wright, & Williams, 2017; Simpson & Mazzeo, 2017). When assessments or analyses grouped diet and fitness trackers together, compared to non-users, users of the trackers were generally found to have higher levels of eating psychopathology (Hefner et al., 2016; Plateau et al., 2018; Sarcona et al., 2017) and compulsive exercise (Hefner et al., 2016; Plateau et al., 2018). Considering diet trackers separately, use of these has been associated with higher body dissatisfaction (Embacher Martin et al., 2018), although associations with broader eating psychopathology are more variable. While one study reported no association between use of diet trackers, and eating psychopathology and compulsive exercise (Plateau et al., 2018), another study found that users had higher levels of eating concern and dietary restraint than non-users (Simpson & Mazzeo, 2017). Regarding fitness trackers, one study observed that, while no differences between users and non-users of fitness trackers were found, a multiple regression model indicated that their use explained variance in eating psychopathology that was not explained by other variables (e.g., gender, diet tracker use; Simpson & Mazzeo,

2017). Another study also reported that use of fitness trackers was associated with exercising for weight-control, dietary restraint and weight concerns (Plateau et al., 2018). Overall, there is large variability in the findings across these studies, although evidence supporting an association between fitness tracker use, and eating and exercise psychopathology is arguably more consistent.

The variability in these studies' findings could be due to the heterogeneity between each diet and fitness tracker, such as providing different information (e.g., calorie-intake, steps), or influencing behaviour in different ways (e.g., facilitating self-monitoring, rewarding behaviour; e.g., Lyons et al., 2014). Reducing this complexity, two cross-sectional studies have focused on the use of one app, *MyFitnessPal*, in relation to eating pathology (Levinson et al., 2017; Linardon & Messer, 2019). The main functions of *MyFitnessPal* enable users to set goals concerning weight, and calorie- and macronutrient-intake, and assess their goal progress by: 1) estimating and tracking their calorie- and nutrient-intake (e.g., consulting a food database, scanning barcodes, creating their own entries for foods); 2) estimating and tracking calorie-expenditure (e.g., logging exercises, tracking steps); and 3) recording their weight with optional photos of their body (Under Armour Inc., 2019). In one of the two studies focusing on *MyFitnessPal* (Linardon & Messer, 2019), in a sample of men recruited from health and fitness websites, users of the app indicated higher levels of eating disorder symptomatology than non-users. Regarding *MyFitnessPal*'s perceived effect, approximately half (47%, 26/55) of the users in the male sample (who had answered the question) described the app as, at least, somewhat contributing to disordered eating. In the other study (Levinson et al., 2017), roughly three-quarters of predominantly female patients with eating disorders had used the app. Compared to the male sample in Linardon and colleagues' study, a larger proportion of the users in the female, clinical sample – approximately three-quarters (73%, 57/78) – viewed it as, at a minimum, having somewhat contributed to their condition (Levinson et al., 2017). In both studies, viewing the app as contributing to an eating disorder or disordered eating was generally associated with higher levels of eating psychopathology. Taken together, both of these studies clearly

demonstrate the importance of understanding how *MyFitnessPal* use relates to eating disorder symptomatology.

While the heterogeneity in the trackers could explain the variability between the findings of these cross-sectional surveys, it could also be due to differences in the measurement across the studies. Indeed, none of the previously discussed studies assessed the use of, or attitudes towards, the trackers in the same way. As previously discussed, engagement with digital devices is complex, comprising several aspects (e.g., attention, duration, frequency) that are influenced by other factors (e.g., demographics, motivations; Perski et al., 2016). However, the majority of the cross-sectional surveys neglected this nuance, and assessed use dichotomously (i.e., participants categorised as 'users' or 'non-users'; Embacher Martin et al., 2018; Levinson et al., 2017; Linardon & Messer, 2019; Sarcona et al., 2017; Simpson & Mazzeo, 2017). Such dichotomous assessment is problematic, as it could increase false positive error rate, underestimate variation in the sample, and conceal non-linearity (Altman & Royston, 2006; Austin & Brunner, 2004). These issues could lead to reporting a relationship when there is actually insufficient evidence, or failing to identify a more complex relationship. Although two studies represent an improvement and assessed the frequency of use (Hefner et al., 2016; Plateau et al., 2018), other aspects of engagement have not been considered. Consequently, patterns of engagement with diet and fitness trackers that are particularly indicative of high levels of eating and exercise psychopathology might remain unidentified. Additionally, issues with item-wording might have resulted in inadvertently influencing participants to give an affirmative response (e.g., "Did you feel that My Fitness Pal contributed to your eating disorder in any way?"; Levinson et al., 2017), which could lead to overestimating the effect of these trackers. However, despite the methodological issues outlined above, as several studies reported that use of the trackers is associated with higher levels of eating and exercise psychopathology, the area clearly warrants further research to elucidate the understanding of this relationship.

Experimental evidence

Due to the previously outlined studies being cross-sectional in nature, they are limited to making conclusions about associative relationships. In contrast, two experimental studies have assessed a causal relationship between diet and fitness tracker use, and eating disorder symptomatology (Jospe et al., 2018; Kerner, Burrows, & McGrane, 2019). In one study, a sample of 169 overweight or obese adults, participants were randomised to one of five conditions, including one in which they were asked to use *MyFitnessPal* to monitor their diet (Jospe et al., 2018). Over a 12-month period, compared to their baseline scores and a control group who did not self-monitor, no evidence was found for a significant effect of using *MyFitnessPal* on eating disorder symptomatology. While this suggests no causal relationship, this is perhaps the result of a weak manipulation, as participants were asked to self-monitor diet daily for the first month, but for only one week of each of the remaining 11 months (i.e., ~15 weeks, or 29% of the year; Jospe et al., 2017). Consequently, the effect of *MyFitnessPal* might have been attenuated by the majority of weeks not requiring use of the app. In contrast, wearing a fitness tracker for a 5-week period was reported to decrease body dissatisfaction in 14 to 15 year old teenagers (Kerner et al., 2019). However, in the absence of a control group and assessment of the teenagers' actual engagement with the tracker, it is difficult to rule out other factors influencing this finding.

Qualitative evidence

The heterogeneity in methods used in the cross-sectional and experimental studies makes synthesis of evidence in this area difficult. For example, due to self-report items (and response scales) differing between each cross-sectional survey, it is difficult to appraise the extent to which the assessed constructs overlap. As such, the assessment of more elemental constructs would facilitate evidence synthesis (e.g., Smith et al., 2009). However, for such a construct and associated assessment instrument to be developed in this area, substantive validity evidence is first required. Qualitative research investigating the nature of diet and fitness tracker use in relation to eating and exercise pathology is therefore highly important.

Two such studies obtained qualitative insights from 16 young women who self-reported eating disorder symptoms (Eikey & Reddy, 2017), and from 13 users who posted comments including eating disorder-related terms (e.g., 'anorexia') on an unspecified weight-loss app's forum (Eikey et al., 2017). Additional, less eating disorder-specific qualitative insights come from an open-response survey completed by 95 mostly young, male users of diet and fitness trackers (Honary et al., 2019). These studies identified several cognitive and emotional factors associated with the use of the trackers. For example, anxiety and guilt were reported in relation to their use, as well as feeling positive when undereating in relation to a goal. Obsessive and perfectionistic tendencies were also observed regarding tracking calories and macronutrients, as was the use of trackers encouraging competition with oneself. In terms of behavioural consequences, participants generally reported that using trackers facilitated eating less, and encouraged purging.

A particularly important issue identified in the qualitative studies was the use of diet and fitness trackers in relation to eating disorder recovery (Eikey & Reddy, 2017; Honary et al., 2019). Specifically, while some participants reported using trackers to encourage them to eat more calories in recovery, others felt the need to stop using these when recovering. Exploring these contrasting views further, a later study found that the majority (54%, 13/24) of a sample of women with self- or clinically-diagnosed eating disorders would not recommend that someone with a similar condition uses the trackers (Eikey et al., 2019).

While the above studies provided valuable findings, they identified few insights into engagement patterns with the trackers, except for use multiple times daily, and selectively not reporting information (e.g., exercise, calorie-intake exceeding a goal). Furthermore, due to the relatively small sample sizes of these studies, the substantive evidence they provide might not be comprehensive, meaning pathological patterns of engagement might remain undetected.

3.1.3. Other forms and focuses of behavioural self-monitoring

The previous subsection focused on technology that supports behavioural self-monitoring in relation to eating and exercise psychopathology. However, behaviour change techniques can take many different forms (e.g., Dombrowski et al., 2016). Indeed, CBT-E recommends behavioural self-monitoring using paper sheets (Fairburn, 2008). Consequently, focusing solely on one form of behavioural self-monitoring in relation to eating and exercise psychopathology risks an incomplete understanding of the issue. However, little attention has been paid to other forms of behavioural self-monitoring in this area.

This issue has been avoided in some research by not making explicit reference in questions to technology, or any other specific form of self-monitoring. For example, using the item "How often do you typically count the calories that you consume?", a cross-sectional survey found that a higher frequency of dietary self-monitoring was associated with higher eating disorder symptomatology (Romano, Swanbrow Becker, Colgary, & Magnuson, 2018). While many participants might interpret this item as referring to diet trackers, it allows flexibility for other forms, such as keeping paper records, or mentally tracking. In contrast, other research has posed several questions, with each relating to a specific form of behavioural self-monitoring. Regarding the monitoring of one's physical activity, as well as asking about use of fitness trackers (i.e., apps, pedometers), one study also assessed use of heartrate monitors, and equipment with feedback displays (e.g., treadmills, elliptical bicycles; Badau & Badau, 2018). However, while this study also assessed compulsive exercise, it unfortunately did not explore the relationship between this and use of the broader range of technologies.

While these studies (Badau & Badau, 2018; Romano et al., 2018) consider a wider range of forms of behavioural self-monitoring, the focuses are more prescribed. Taking the example of monitoring one's diet, by asking about calories (Romano et al., 2018), the monitoring of other dietary focuses (e.g., macronutrients, quantity in grams, eating episodes) are not assessed. However, due to CBT-E recommending the

self-monitoring of meals, but not calories (Fairburn, 2008), asking separately about both focuses is necessary to facilitate an understanding of their implied differential effects on eating disorder symptomatology. Similarly, regarding the broader assessment of monitoring one's physical activity (Badau & Badau, 2018), having only focused on technological forms, these questions do not consider focuses that cannot be monitored by technology (e.g., interoceptive perceptions, such as physical tiredness). Given interoceptive awareness being an important consideration in relation to eating disorders (e.g., Merwin, Zucker, Lacy, & Elliott, 2010), as well as perceptions such as pain and tiredness being neglected in compulsive exercise (Davis et al., 1997), assessment of these monitoring focuses is also crucial.

One of the most comprehensive considerations of different behavioural self-monitoring focuses is represented in a measure that aims to assess the frequency of women's social comparisons regarding their body, eating, and exercise (Fitzsimmons-Craft, Bardone-Cone, & Harney, 2012). As detailed in the development of the measure, there was a particular lack of relevant literature related to eating and exercise comparisons, so substantive validity evidence was derived from clinical observations and the researchers' experiences. Following structural validity assessments, the measure's content related to several self-monitoring focuses for both eating (i.e., amount, type and healthiness of food) and exercise (i.e., duration, amount, energy expended, frequency of bouts, intensity). Both eating and exercise comparison scores were subsequently found to be positively associated with eating disorder symptomatology. However, while this measure represents a broader consideration of self-monitoring focuses, it was developed to assess comparisons with peers. Therefore, as previously discussed in relation to body checking scales, it is not possible to make specific conclusions about the more elemental aspects of comparisons (i.e., self-monitoring, reference values). Furthermore, by only assessing comparisons to peers, it lacks a consideration of other reference values (i.e., past or ideal states; Harkin et al., 2016).

3.1.4. Summary

In summary, this section has provided an overview of the evidence concerning the relationship between monitoring one's behaviours (i.e., eating, physical activity), and

eating and exercise psychopathology. In line with the importance of substantive construct validity (e.g., Flake et al., 2017), particular attention was paid to construct conceptualisation and content validity of the studies' measures.

Overall, there appear to be four major attributes of behavioural self-monitoring, the breadth of which should be considered in its conceptualisation and measurement in relation to eating and exercise psychopathology. These four aspects concern: its form; its focus; its engagement; and its overlap with theoretically related constructs. First, in relation to its form, current evidence has predominantly focused on technology-enhanced behavioural self-monitoring (i.e., using diet or fitness trackers), but has neglected other forms (e.g., pen and paper, mental tracking; cf. Dombrowski et al., 2016). Second, while broad distinctions have been made concerning behavioural self-monitoring focuses (e.g., distinguishing between diet and fitness trackers), more specific distinctions require greater consideration (e.g., monitoring meals or calories; cf. Fairburn, 2008). Third, engagement has been insufficiently considered in the current literature, with survey-based studies having assessed either use or non-use (e.g., Simpson & Mazzeo, 2017), or frequency of use (e.g., Plateau et al., 2018). Last, the majority of research does not permit strong conclusions to be made about self-monitoring itself, as it cannot be distinguished from theoretically related variables. For example, by assessing the use of trackers, the relationship with other behaviour change techniques present within the technologies has also been assessed (e.g., rewarding behaviour; Lyons et al., 2014). Similarly, by assessing comparisons, the relationship with self-monitoring cannot be separated from that of comparing to a specific reference value (e.g., peers; Fitzsimmons-Craft, Bardone-Cone, et al., 2012).

In light of several attributes of behavioural self-monitoring not having been sufficiently considered, research that considers the broader construct is required. Without considering the broader range of attributes, important factors that are associatively or causally related to eating and exercise psychopathology might not be identified. This is particularly important to consider when interpreting null relationships, as such findings could simply reflect that important, potentially pathological aspects of behavioural self-monitoring have not been assessed or

manipulated. For example, while one study found that the frequency of diet tracker use was not associated with eating disorder symptomatology (Plateau et al., 2018), other aspects of engagement might be (e.g., duration, temporal proximity).

3.2. Broad aims of this thesis

In comparison to monitoring behavioural outcomes (i.e., 'body checking'), there is a relative paucity of research that has investigated the nature of self-monitoring one's behaviour (e.g., eating, exercise) in relation to eating psychopathology. Furthermore, the research that has investigated self-monitoring one's behaviour in this context is limited in terms of its focus and methodological rigor. For example, such studies have tended to focus on one aspect of engagement (e.g., frequency of monitoring), and one form of self-monitoring (i.e., tracking devices or apps). A focus on technological devices or apps is particularly problematic as they are heterogeneous in nature, and might therefore affect behaviour in different ways (e.g., facilitating self-monitoring, rewarding behaviour; e.g., Lyons et al., 2014). Consequently, the variation in these technologies might obfuscate relationships between self-monitoring one's behaviours and eating psychopathology. As demonstrated in relation to body checking (Study 1), such heterogeneity has detrimental consequences for the precision of a study's findings, and, therefore, their clinical utility (e.g., Strauss & Smith, 2009).

In order to address these problems, the broad aim of this thesis is to elucidate aspects of self-monitoring one's behaviour that require consideration in relation to eating psychopathology. While several behaviours are considered particularly important in the context of eating disorders (e.g., eating, purging), this thesis will focus primarily on the self-monitoring of physical activity. The primary reason for focusing on physical activity is that it is relatively neglected in eating disorder research (Touyz et al., 2017) and, therefore, requires greater attention. Furthermore, several studies have emphasised the particular importance of considering physical activity self-monitoring. For example, the use of fitness trackers (compared to diet trackers) tends to be more strongly associated with eating psychopathology (Plateau et al., 2018;

Simpson & Mazzeo, 2017), and patients with eating disorders are indicated to under-report their exercise (Bezzina et al., 2019; Bratland-Sanda et al., 2010). Additionally, while not captured within current measures of compulsive exercise (e.g., CET; Taranis et al., 2011), monitoring and recording one's exercise has previously been suggested to be an important aspect of this construct (e.g., Adkins & Keel, 2005). As such, understanding the nature of self-monitoring physical activity in the context of compulsive exercise warrants particular consideration.

3.2.1. Research question

The overarching research question for this thesis is:

> *How should physical activity self-monitoring be conceptualised in relation to eating psychopathology and compulsive exercise?*

In other words, this thesis aims to provide comprehensive substantive evidence for the physical activity self-monitoring construct in people with high levels of eating psychopathology and compulsive exercise.

3.2.2. Research aims

In response to this question, this thesis aims to:

1) Elucidate the ways in which people with high levels of eating psychopathology engage with fitness trackers (Studies 2 and 3).
2) Identify the varied forms and focuses of physical activity self-monitoring (Study 4).
3) Investigate the ways in which compulsive exercisers engage in physical activity self-monitoring (Study 5).
4) Generate and evaluate the comprehensiveness of insights into how people with high levels of eating psychopathology engage in physical activity self-monitoring (Studies 6 and 7).

3.3. Overview of methodological approach used in thesis

This section provides a broad overview of the data sources, analytic strategies and ethical considerations relating to the studies comprising this thesis. Detailed descriptions of the methodologies are provided in the chapters corresponding to each individual study (chapters 4 to 9).

3.3.1. Data sources

The studies comprising this thesis used data that were primarily textual in nature. Due to the overall aim concerning the generation of substantive evidence for a construct, qualitative aspects of these textual data were particularly valuable (Brod et al., 2009; Podsakoff et al., 2016), although quantitative attributes were also investigated. Additionally, reflecting the dimensional perspective of psychiatric disorders adopted by the thesis, the studies presented in the following chapters collected data that aimed to capture the normal to abnormal range of the construct, rather than focusing on clinical populations (e.g., Cuthbert & Kozak, 2013; Wildes & Marcus, 2015). In line with these considerations, the studies comprising this thesis used data from three sources: a survey; semi-structured interviews; and online forums (i.e., social media). A brief overview of each data source is now presented.

Survey

A survey was used to collect textual data that were the basis for Study 4. In brief, the survey involved posing an open-ended question to investigate the variety of forms and focuses of physical activity self-monitoring. Reflecting this thesis's aim to capture a range of normal to abnormal experiences, the survey was widely advertised using print and online advertisements. For example, the advertisement was disseminated over social media (i.e., *Twitter*, *Facebook*, *Reddit*) by approximately 40 groups or organisations that concerned different topics (e.g., food, sport, mental health). Together with broad inclusion criteria and conducting the survey online, this recruitment strategy resulted in a dataset comprising 3,495 textual responses from a diverse sample. Addressing a secondary aim of the survey, participants were asked

to complete a series of self-report questions. The answers to these questions were used to describe the sample, and recruit participants for the subsequent interviews.

Semi-structured interviews

While the survey posed one open-ended question, semi-structured interviews were conducted due to the suitability of this methodology for capturing more detailed accounts of the participants' experiences (e.g., McArdle, McGale, & Gaffney, 2012). Specifically, the interviewees were asked a range of questions to investigate the ways in which they engage in physical activity self-monitoring. As previously outlined, compulsive exercise is a potentially important consideration in relation to physical activity self-monitoring. Accordingly, all 13 interviewees were selected based on having indicated high levels of compulsive exercise, as assessed in the survey using the CET (Taranis et al., 2011). In line with the dimensional approach to psychiatric disorders (e.g., Cuthbert & Kozak, 2013), levels of eating disorder symptomatology, and history of related diagnoses, varied within this sample. These interviews are reported in detail in chapter 7 (Study 5).

Online forums

Textual comments from online forums were used as the basis for four studies: two qualitative studies (Studies 3 and 7); and two quantitative studies (Studies 2 and 6). The quantitative studies were conducted using these data to: appraise the relevance of these comments to physical activity self-monitoring (Study 2); and to enable grouping the comments in terms of whether they were contributed by people indicating a high and/or low focus on eating disorder recovery (Study 6).

Online forums take a variety of forms, but can all generally be viewed as providing a platform for their users to have conversations with each other. While some forums are general in terms of the topics of discussion, more commonly, an individual forum tends to focus on a specific topic (e.g., films, sports, politics). As such, the users of an online forum can be seen to have a shared interest. Due to the variety and ubiquity of public online forums, they represent a valuable source of textual data that can be used to improve the understanding of a wide range of topics. Indeed, a key consideration for construct conceptualisation is that substantive evidence reflects

"how participants think about the focal construct in their own words, with minimal prompting from the researcher" (Gehlbach & Brinkworth, 2011, p382). Therefore, content from online forums is particularly valuable, as it is unprompted by researchers, and so undoubtedly represents the focal construct in the sample's own words.

In relation to eating disorders, online content and forums can be defined broadly as either 'pro-eating disorder', or 'pro-recovery' (e.g., Branley & Covey, 2017). Pro-eating disorder content is suggested to: encourage the enactment of weight-control behaviours (e.g., dieting, purging) without a desire for recovery; portray eating disorders as a lifestyle choice, rather than a mental health condition; and include 'thinspiration', which is primarily image-based pro-eating disorder content. In contrast, pro-recovery (or 'anti-eating disorder') content encourages recovery from eating disorders. In addition to the distinction between pro-eating disorder and pro-recovery content, online eating disorder forums can also be characterised as relating to eating disorders in general, or specific diagnostic categories (e.g., anorexia nervosa).

Cross-sectional surveys investigating engagement with pro-eating disorder and pro-recovery online forums have indicated that, on average, the users have high, and often clinically significant levels of eating psychopathology (e.g., Aardoom, Dingemans, Boogaard, & Van Furth, 2014; Harper, Sperry, & Thompson, 2008; Peebles et al., 2012). However, due to the typically anonymous nature of online forums (i.e., use of pseudonyms; van der Nagel & Frith, 2015), it is difficult to elucidate an individual user's level or experience of eating psychopathology. As such, it is difficult for researchers to identify, and therefore exclude content that is provided by forum users with low levels of eating psychopathology. While the forums might contain content provided by people with varying degrees of eating psychopathology, this is advantageous for the purpose of developing a construct in line with a dimensional approach to psychiatric disorders (i.e., capturing the normal to abnormal range of a construct; e.g., Cuthbert & Kozak, 2013). Furthermore, the inclusion of content from pro-eating disorder forums is highly valuable, as their users are viewed as engaging in eating disorder-related behaviours without a desire for

recovery (Branley & Covey, 2017). As such, content from pro-eating disorder forums offers the potential to understand the experiences of people experiencing high levels of eating psychopathology, but who are not seeking treatment, and are therefore not captured within solely clinical samples.

Previous research has used data from online eating disorder forums hosted on a range of social media platforms, such as *Facebook* (e.g., Teufel et al., 2013), *Twitter* (e.g., Tiggemann, Churches, Mitchell, & Brown, 2018; Wang, Brede, Ianni, & Mentzakis, 2018), *Instagram* (e.g., Talbot, Gavin, van Steen, & Morey, 2017), and *Reddit* (e.g., Lyons, Mehl, & Pennebaker, 2006; Moessner, Feldhege, Wolf, & Bauer, 2018; Sowles et al., 2018). For three main reasons, *Reddit* (Reddit Inc., 2019) was used as the source of eating disorder-related online data for four studies reported in this thesis (Studies 2, 3, 6 and 7). First, compared to primarily image-based content on other platforms (e.g., *Instagram*), the content contributed to *Reddit* is primarily textual in nature, and was therefore more valuable for the purpose of construct conceptualisation. Second, while *Reddit* does allow private subreddits, a large number are public in comparison to forums hosted on other platforms (e.g., *Facebook*). Last, there are no restrictions on how much text a user can contribute to *Reddit*, while other platforms limit this (e.g., 280 characters for a *Twitter* post).

Reddit had an estimated 330 million users in 2018 (Pardes, 2018), and, at the time of writing, is one of the most visited websites worldwide (Alexa Internet Inc., 2019). In brief, as a large online discussion platform, *Reddit* comprises hundreds of thousands of individual forums (i.e., 'subreddits') that each correspond to a particular topic, including eating disorders. Once a user has become a member of a subreddit, they can either post a comment to begin a conversation (i.e., a 'thread'), or can respond to a comment to continue the thread. The *Reddit* data were accessed through a freely available archive of all public comments (excluding the initial post) made on the platform since December 2005 (Complete Public Reddit Comments Corpus, 2018). For each comment, the archive contains a variety of information, including the text of the comment, the subreddit to which it was posted, and the username of the commenter. Due to the large amount of data stored in this archive, code was developed and written using *Python* programming language (Python Software

Foundation, 2017) to automate the extraction of specific data for each study. As the comments were naturally occurring language, further processing using the Natural Language Toolkit package (Bird, Klein, & Loper, 2009) was undertaken to mitigate issues in detecting relevant comments (e.g., due to variations in punctuation). For each study using these data, more detail for the specific approach to data extraction is presented in the respective chapter.

Data triangulation

As outlined in this subsection, a variety of data sources were used in the studies comprising this thesis. As all these studies broadly aimed to generate insights into physical activity self-monitoring in relation to eating psychopathology and compulsive exercise, the different sources of data enabled the triangulation of the findings of these studies (e.g., Erzberger & Prein, 1997; Lincoln & Guba, 1985; Munafo & Davey Smith, 2018). In other words, the different data sources mitigate the possibility that the overall findings of this thesis result from biases related to one particular data source. For example, by posing questions in the survey and interviews, it is possible that the wording of these influenced participants' answers. However, the comments posted to online forums are not subject to this issue, as they are unsolicited and therefore not influenced by the researcher. Similarly, while a limitation of using comments from online forums is that it is not possible to ascertain the users' characteristics, the use of self-report scales in the survey overcomes this issue. Due to the variety of data sources detailed previously, Table 3 presents an overview of the six studies presented in the following chapters, and summarises each study's aim, sample, methodology, and outcomes.

Table 3. Summary of studies comprising thesis

Study	Aim	Sample	Methodology	Outcomes
2	Evaluate relevance to physical activity self-monitoring of comments made on eating disorder subreddits	40,210 threads from three eating disorder subreddits, and 337,066 threads from three health-related subreddits	Text-mining and word-count approach	Proportion of a subreddit's threads that include at least one mention of fitness trackers
3	Investigate engagement with *MyFitnessPal* as discussed by commenters on eating disorder subreddits	1,695 comments – contributed by 920 commenters – that were made on eating disorder subreddits and mentioned *MyFitnessPal*	Inductive thematic analysis	Themes and subthemes
4	Identify the forms and focuses of physical activity self-monitoring	Responses from 3,495 participants to a sentence-completion task in an online survey	Inductive thematic analysis	Themes and subthemes
5	Explore the nature of physical activity self-monitoring as described by people with high levels of compulsive exercise	Semi-structured interviews with 13 people who indicated high levels of compulsive exercise	Inductive thematic analysis	Themes and subthemes
6	Examine commenting patterns to identify commenter-overlap in eating disorder subreddits	14,024 commenters who commented on eating disorder subreddits	Network analysis, text-mining and word-count approach, manual review	Detection and interpretation of communities of commenters
7	Evaluate comprehensiveness of previous insights into physical activity self-monitoring	1,949 comments – contributed by 976 commenters – that were made on eating disorder subreddits and mentioned physical activity self-monitoring; extracted separately for people with high and/or low focuses on recovery (informed by Study 6)	Hybrid (deductive and inductive) thematic analysis	Themes and subthemes, and extent to which new codes were identified

3.3.2. Data analyses

As mentioned in the previous subsection, both qualitative and quantitative analytic approaches were used in the studies comprising this thesis. These approaches are broadly outlined below in turn.

Qualitative analyses

Qualitative insights were particularly valuable for achieving the aims of this thesis, due to its focus on construct conceptualisation (cf. Brod et al., 2009; Podsakoff et al., 2016). As such, thematic analysis (Braun & Clarke, 2006; Braun, Clarke, & Weate, 2016), a qualitative analytic technique, was used to analyse textual data obtained from the previously outlined sources (i.e., survey, interviews, online forums). In general, thematic analysis facilitates the description and interpretation of patterns within a textual dataset, by grouping these patterns into meaningful 'themes' (Braun & Clarke, 2006; Braun et al., 2016). While a range of other qualitative techniques exist, thematic analysis was particularly suitable for the aims of this thesis due to the flexibility with which it can be used (e.g., Braun & Clarke, 2006). Specifically, thematic analysis does not prescribe the way data should be collected or sampled (cf. varied data sources reported in this thesis), nor is it associated with a theoretical framework. However, as a result of this flexibility, it is crucial to specify clearly the way in which thematic analysis is conducted (e.g., Holloway & Todres, 2003). In particular, three aspects should be clearly stated (e.g., Braun et al., 2016): whether an inductive or deductive approach is used; whether themes are identified at a semantic or latent level; and the type of epistemological stance that is adopted.

An inductive (i.e., 'bottom-up') approach provides a rich overall description of a textual dataset, as themes are not specified before the analyses, and are therefore based in the data (Patton, 1990; Vaismoradi, Turunen, & Bondas, 2013). In contrast, a deductive (i.e., 'top-down') approach specifies the themes to be coded beforehand, and is therefore less open to novel insights being identified (Braun & Clarke, 2006). Accordingly, as this thesis broadly aimed to identify previously undetected aspects of physical activity self-monitoring (i.e., forms, focuses, engagement), an inductive approach was used for all thematic analyses to capture the breadth of the construct

represented in the data (cf. Clark & Watson, 2019). Additionally, the themes reported in this thesis were typically identified at a semantic level – i.e., the themes were identified based on meanings that were clearly represented in the data, and did not require substantial interpretation of the implicit meaning of the text (i.e., latent level themes; Braun & Clarke, 2006; Braun et al., 2016). Last, a critical realist epistemological stance was adopted for all thematic analyses reported in this thesis. In brief, critical realism argues that our knowledge of reality (i.e., epistemology) constitutes only a small part of what is real (i.e., ontology; e.g., Fletcher, 2016). As such, from a critical realist perspective, different understandings of reality can vary with regard to how close each is to reality (i.e., how correct each is). In relation to the studies reported in this thesis, the extent to which each thematic analysis is correct might be influenced by the source of data (i.e., survey, interviews, online forums). For example, the interviewees might be biased to respond in ways that they believe will be perceived favourably, resulting in the explanation based on their responses being less close to reality than if they had responded honestly. Similarly, commenters on pro-eating disorder forums might only discuss their experiences that are congruent with the community's views (e.g., not indicating a desire for recovery). However, due to the triangulation afforded by the different data sources, the overall explanation generated from all studies in this thesis aims to be closer to reality than the explanation generated from each individual study.

The practical application of thematic analysis is summarised in six steps (Braun & Clarke, 2006; Braun et al., 2016). The first step concerns becoming familiar with the data, which includes thorough readings of the text, and making initial notes about meanings that are present within the data. In the case of the interviews (Study 5), this also involved manually transcribing the audio recordings. Second, an initial set of codes are developed. Each code represents an aspect of the data that is meaningful, and should be as specific as possible. For example, if 'anxiety' were mentioned, this term would be a more useful initial code than a more general label, such as 'emotion'. The development of initial codes in the subsequent thematic analyses was facilitated by the qualitative software, *NVivo* (QSR International Pty Ltd., 2018). Steps three and four relate to identifying and reviewing themes, respectively. Overall, these steps

involve consolidating the initial codes into meaningful groups. For example, at this stage, the codes 'anxiety' and 'happiness' might be grouped as representing the theme 'emotions'. An important consideration at this point parallels recommendations for construct conceptualisation (Clark & Watson, 2019). Specifically, themes should be both internally homogenous (i.e., be clear what they *are*) and externally heterogeneous (i.e., be clear what they *are not*; Patton, 1990). For example, while the theme 'emotions' (including 'anxiety' and 'happiness') might be conceptually homogenous, it might be decided that differences in the valence of these codes require representation in separate subthemes, such as 'negative emotions' (e.g., 'anxiety', 'sadness') and 'positive emotions' (e.g., 'happiness', 'pride'). The final steps (five and six) of thematic analysis involve defining and labelling the themes, and producing the report, respectively. These steps lead to a formalisation of the analysis, although they might also highlight the need for further revisions to be made, which requires returning to earlier steps in the analysis.

The concept of rigor in qualitative research is contentious, and commonly used approaches to ensuring this (e.g., interrater reliability, member checking) have been widely criticised (e.g., Braun et al., 2016; Smith & McGannon, 2017; Vaismoradi et al., 2013). Therefore, in line with recent recommendations, the thematic analyses comprising this thesis aimed to ensure rigor by using a 'critical friends' approach (Cowan & Taylor, 2016; Smith & McGannon, 2017; Smith & Sparkes, 2006). This approach involves forming a critical dialogue between the researcher conducting the thematic analysis, and one or more other researchers (i.e., the 'critical friends'). The role of the critical friends is to provide feedback on and challenge the principal researcher's analysis (i.e., coding, development of themes). While there might be agreement between all researchers, offering alternative interpretations, explanations and criticisms is particularly encouraged. The provision of such alternatives enables the principal researcher to reflect on their analysis, and subsequently defend or revise this to ensure that their final thematic structure is coherent, plausible and rigorous.

In order to guide the reporting of the qualitative analyses, the consolidated criteria for reporting qualitative research (COREQ) was used (Tong, Sainsbury, & Craig, 2007).

The first domain concerns the characteristics of the researcher, and their relationship with the participants. As the author of this thesis conducted all of the reported analyses, their characteristics were stable across the studies and are, as such, summarised in this section. Specifically, the researcher was a male PhD student/candidate, held a BSc in Psychology and MSc in Neuropsychology, and had undergraduate and postgraduate training in qualitative research methodologies. Regarding the survey (Study 4) and interviews (Study 5), the researcher had no pre-existing relationship with the participants when conducting each study, and all participants were informed that the researcher was a PhD student/candidate at the University of Warwick. The other COREQ criteria relate to two domains – 2) study design, and 3) analysis and findings – and are addressed in each chapter due to their focus on specific aspects of each individual study (e.g., sampling, sample size).

Quantitative analyses

In this thesis, quantitative analyses were conducted for two main purposes. First, descriptive statistics were used to detail the samples used in each study. For the survey and interviews (Studies 4 and 5), this related to various characteristics of the samples (e.g., demographics, eating psychopathology). Regarding studies using data from *Reddit* (Studies 2, 3, 6 and 7), the statistics corresponded to various attributes of the corpus, including the number of subreddits, comments, commenters and words. The percentage of threads including specific terms was also calculated in two of the *Reddit* studies (Studies 2 and 6). Second, in Study 6, the relationships between subreddits in terms of their overlap in commenters was calculated using a network analytic approach (e.g., Epskamp, Cramer, Waldorp, Schmittmann, & Borsboom, 2012). Due to the quantitative analytic strategies varying across each study, greater detail about these is provided in their respective chapters.

3.3.3. Ethical considerations

The University of Warwick's Biomedical and Scientific Research Ethics Committee was consulted for all studies presented in the following chapters. Due to specific issues regarding the use of social media data in research, the ethical considerations

for the survey and interviews are presented together, followed by an outline of the analyses of data from online forums.

Survey and interviews

Ethical approval was sought and obtained for the survey and interviews together (REGO-2017-2112 AM01). Before completing the online survey, all participants were asked to read information about the study and provided their informed consent to participate online by indicating their agreement with a series of statements. To be invited to participate in an interview, as well as meeting the eligibility criteria (Study 5), participants had to indicate an interest in participating at the end of the survey. When invited to participate in an interview, participants were provided with a link to information about the study and asked to indicate informed consent in the same way as for the survey. Verbal consent to participate was also obtained at the start of each interview. In the information before each study, participants were informed about their right to withdraw. In the case of the survey, participants were informed that they could withdraw by simply closing their internet browser, but that their responses could not be withdrawn after completion of the survey due to the anonymous nature of their participation. Similarly, interviewees were informed that they could withdraw at any time, and that they would not be able to withdraw their responses after the interview, as the audio recording would be anonymised during the transcription process.

To complete the survey, participants were not required to provide any identifiable data, and so their responses were anonymous by nature. If indicating a willingness to participate in an interview, participants provided their name and email address at the end of the survey. After completion of an interview, the participant's name and email address were deleted. The audio recording of an interview was also deleted following transcription. Regardless of their nature, all of the participants' data were handled in accordance with the UK Data Protection Act 1998, and the General Data Protection Regulation, which replaced the Data Protection Act during the period of this research.

Online forums

The role of research ethics committees in analyses of publicly available social media data remains unclear (Chancellor, Birnbaum, Caine, Silenzio, & De Choudhury, 2019). As such, before each of the four studies using data from *Reddit*, the committee above was consulted to confirm their current policy on conducting research using these data. Indeed, while the committee provided confirmation that such analyses were exempt from ethical review for two studies (Studies 2 and 6), their policy changed before conducting the remaining two studies (Studies 3 and 7), and so ethical approval was sought and obtained for both of these analyses together (REGO-2019-2366). Regardless of whether or not ethical review was required, all studies adhered to current guidelines set by the British Psychological Society (2013) for internet-mediated research.

All data from *Reddit* used in these studies were viewable without an account, and could therefore be considered to be within the public domain (cf. Sudweeks & Rafaeli, 1996). As such, in line with the British Psychological Society's (2013) guidelines and previous research (e.g., Williams, Nielsen, & Coulson, 2018), the use of data in the public domain removed the necessity of collecting informed consent from each member of *Reddit*.

Despite the anonymity afforded by *Reddit* through its use of pseudonyms, identifiable data (e.g., names of people or locations) were potentially present within the textual comments. As such, caution was taken not to present any identifiable information in the reports of the qualitative studies. Furthermore, as the data used in the analyses are in the public domain, providing exact quotations from the comments in the reports could lead to users being identified by entering the exact text into an internet browser search. Therefore, all quotations used in the reports were paraphrased and reverse searched in order to ensure that they could not be traced to the original commenter (British Psychological Society, 2013; Williams et al., 2018). Regarding the quantitative analyses of these data, the findings were reported as aggregated statistics (e.g., frequency of word-use), and so it was not possible to identify specific commenters from these results.

3.4. Summary

The broad aims of this thesis are to improve the understanding of how physical activity is self-monitored in the context of eating psychopathology and compulsive exercise. Six studies that address this aim are presented in the following chapters. First, two studies are reported that quantitatively and qualitatively analysed *Reddit* data to investigate the use of fitness trackers in the context of eating psychopathology (Studies 2 and 3). As fitness trackers represent one form of physical activity self-monitoring, a large-scale survey (Study 4) and interviews with people with high levels of compulsive exercise (Study 5) are then presented that aimed to identify the breadth of the construct. Following an analysis of the commenting patterns of commenters on eating disorder subreddits (Study 6), data from *Reddit* are then further analysed to develop a more comprehensive understanding of the physical activity self-monitoring construct (Study 7). Finally, a general discussion of the overall findings of the research comprising this thesis is presented (chapter 10).

4. Study 2:

Evaluating online eating disorder-related content for the purpose of conceptualising physical activity self-monitoring

The study presented in this chapter has been published in the *International Journal of Eating Disorders* (McCaig, Bhatia, Elliott, Walasek, & Meyer, 2018). Consequently, the content presented in this chapter is adapted from the published article.

4.1. Introduction

As comments made on online forums are not influenced by researchers, they represent a valuable source of data to generate insights into how people think about and discuss a construct in their own words (cf. Gehlbach & Brinkworth, 2011). However, due to the lack of control a researcher has in influencing the topics of discussions, it is possible that no conversations about the construct of interest take place in a specific forum. Consequently, in line with the aims of this thesis, it was necessary to appraise the suitability of content from eating disorder subreddits (i.e., forums on *Reddit*) for gaining insights into the self-monitoring of physical activity. While a previous content analysis of 180 eating disorder websites identified that users shared charts of energy-expenditure on 25 (14%) of the websites (Borzekowski, Schenk, Wilson, & Peebles, 2010), it was important to scope the *Reddit* data for such content. Similarly, while a semantic analysis (latent Dirichlet allocation) of comments on a weight-management subreddit found that fitness trackers were mentioned within approximately 3% the forum's comments (21,081/101,003; Pappa et al., 2017), it was also necessary to identify such discussions on eating disorder subreddits.

The use of fitness trackers represents one form of physical activity self-monitoring, and has been investigated, typically using cross-sectional surveys, in relation to eating psychopathology and compulsive exercise (e.g., Plateau et al., 2018). However, different fitness trackers – and versions or models of the same fitness tracker – can vary greatly, such as in the information they provide, or the ways in which they influence behaviour (e.g., Lyons et al., 2014). Due to this heterogeneity, comparative reviews of fitness trackers are valuable. For example, Lyons and colleagues (2014) reviewed 13 fitness trackers by wearing each for one week, and coding them using the behaviour change technique taxonomy (Michie et al., 2013).

A summary of the findings from Lyons and colleagues' coding is presented in Table 4 to exemplify the heterogeneity between these devices.

Table 4. Differences between fitness trackers

Fitness tracker	Monitoring focus of fitness tracker							Presence of behaviour change technique category in fitness tracker												
	Physical activity																			
	Steps	Stairs	Distance	Energy-expenditure	Food	Weight	Heart rate	Goals and planning	Feedback and monitoring	Social support	Shaping knowledge	Natural consequences	Comparison of behaviour	Associations	Repetition and substitution	Comparison of outcomes	Reward and threat	Antecedents	Scheduled consequences	Self-belief
Basics	✓						✓	✓	✓						✓		✓	✓	✓	✓
Body-Media (Fit)	✓				✓	✓	✓	✓	✓			✓					✓	✓		✓
Fitbit (Force)	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓		✓		✓	✓		✓
Fitbug (Orb)	✓		✓	✓	✓	✓		✓	✓		✓	✓						✓		✓
Gruve				✓				✓	✓			✓		✓		✓		✓		
Ibitz (Unity)	✓		✓	✓		✓		✓	✓	✓			✓				✓	✓		
Jawbone Up24	✓				✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Lumo (Back)	✓		✓	✓				✓	✓				✓	✓			✓	✓		✓
Misfit (Shine)	✓		✓	✓	✓	✓		✓	✓	✓			✓				✓	✓		
Nike (Fuelband SE)	✓			✓				✓	✓	✓		✓	✓	✓	✓		✓	✓	✓	✓
Polar (Loop)	✓			✓			✓	✓	✓	✓		✓	✓	✓			✓	✓		
Striiv (Play)	✓	✓	✓	✓		✓		✓	✓	✓			✓	✓	✓			✓	✓	
Withings (Pulse)	✓					✓	✓	✓	✓	✓		✓		✓			✓	✓		

N.B. Table 4 summarises selected findings from Lyons and colleagues' (2014) review of fitness trackers.

The study reported in this chapter specifically aimed to identify discussions about fitness trackers in eating disorder subreddits. To achieve this aim, the study adopted a computerised text-mining approach, which enables the identification and extraction of specific information from a large corpus of textual data (Abbe, Grouin, Zweigenbaum, & Falissard, 2016). More specifically, a word-count technique was developed that was comparable to existing methods, such as the Linguistic Inquiry and Word Count analysis programme (LIWC; Tausczik & Pennebaker, 2009). While LIWC assesses the extent to which existing sets of words are present within a text, the current study first developed a list of fitness tracker terms, and then determined the frequency with which these terms were used in eating disorder subreddits. In other words, the main aim of this exploratory study was to identify and quantify interest in (i.e., mentions of) fitness trackers in eating disorder subreddits. As a secondary aim, the study compared levels of interest in fitness trackers between different types of eating disorder subreddit (i.e., pro-eating disorder, pro-recovery) and health-related communities (i.e., fitness, weight-management, nutrition), which aimed to provide greater insight into the context in which such trackers are discussed.

4.2. Methods

To achieve this study's aims, six subreddits were selected to create the data corpus. These subreddits consisted of three related to eating disorders, and three related to health (i.e., fitness, weight-management, nutrition). Following the generation of a list of search terms related to fitness trackers, the data of interest (i.e., information concerning each comment posted on the subreddits) were extracted and pre-processed, and threads of comments were concatenated. The data were then analysed, which included summarising the corpus' characteristics, and comparison of the subreddits regarding the frequency with which the fitness tracker search terms were mentioned. The University of Warwick's Biomedical and Scientific Research Ethics Committee confirmed that these analyses were exempt from ethical review. A flowchart summarising the procedure used in this study is presented in Figure 5.

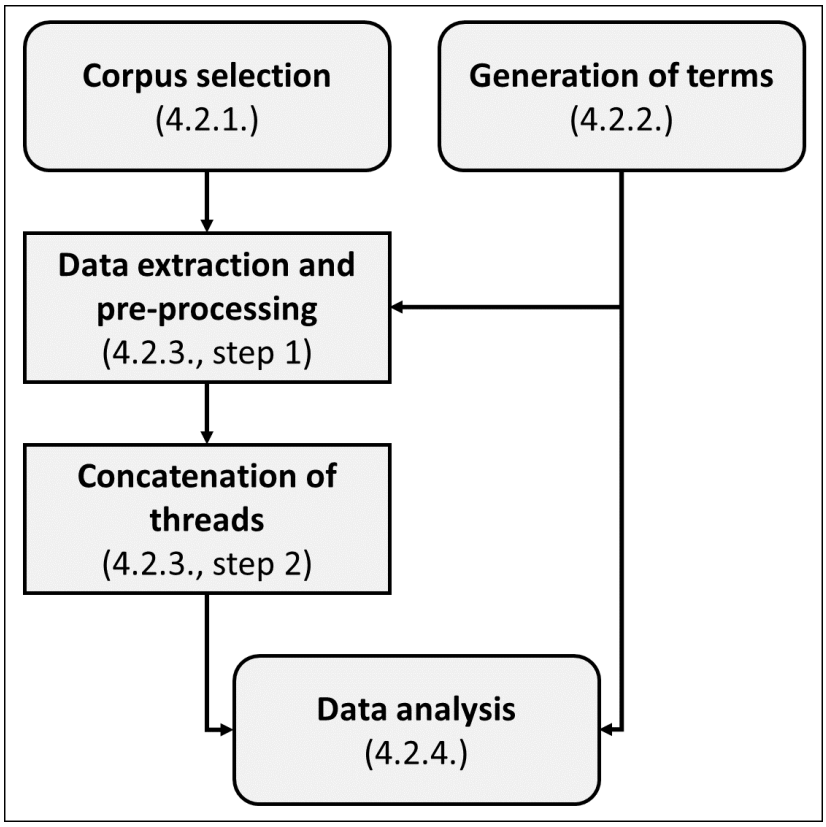

Figure 5. Procedural flowchart

4.2.1. Corpus selection

Reddit's search bar was used to identify eating disorder subreddits that contained one or more eating disorder-related terms in their name and/or description. This list of terms was generated through consultation of two clinical references (DSM-V; American Psychiatric Association, 2013; ICD-10; World Health Organization, 1992), and previous research (e.g., Branley & Covey, 2017; Chancellor, Lin, Goodman, Zerwas, & De Choudhury, 2016). The following search terms were developed that related to eating disorders in general: "eating disorder", "eating disorders", "eating disordered", "eatingdisorder", "eatingdisorders", "eatingdisordered", "disordered eating", "disorderedeating", "ed", "eds", "proed", "proeds", "pro-ed" and "pro-eds". Due to the focus on fitness trackers, the following search terms were also developed for eating disorder diagnostic categories that included explicit criteria relating to exercise (i.e., Anorexia Nervosa and Bulimia Nervosa): "anorexia", "anorexic",

"anorexics", "proanorexia", "pro-anorexia", "ana", "proana", "pro-ana", "bulimia", "bulimic", "bulimics", "probulimia", "pro-bulimia", "mia", "promia" and "pro-mia". From the resultant list of eating disorder subreddits, the three with the most threads were selected for inclusion. These were *r/proED*, *r/fuckeatingdisorders* and *r/EatingDisorders*. Large health-related subreddits with over 150,000 subscribers were also included in the corpus to explore the context in which the fitness trackers were most frequently mentioned. Three subreddits were selected that each related to one of three eating disorder-related behaviours, or behavioural outcomes – eating (*r/nutrition*), body shape and weight (*r/loseit*, a weight-management subreddit), and exercise (*r/Fitness*). Descriptions of the six included subreddits are presented in Table 5.

Table 5. Names and descriptions of subreddits included

Subreddit name	Subreddit description
Eating disorder subreddits	
r/proED	"**This is a place to discuss eating disorders, extreme/fringe eating behaviors, thinspo and recovery."
r/fuckeatingdisorders	"Eating disorders have many misconceptions, and part of that is because those who have it hide it since those who don't have it don't understand it because no one talks about it. FED is here to confront eating disorders and provide a place for anyone to ask questions."
r/EatingDisorders	"## For Awareness, Information, and Questions about Recovering from EDs. We are a pro-recovery site, and only allow approved posts."
Health-related subreddits	
r/Fitness	"This subreddit is for discussion of physical fitness goals and how they can be achieved."
r/loseit	"A place for people of all sizes to discuss healthy and sustainable methods of weight loss. Whether you need to lose 2 lbs or 200 lbs, you are welcome here!"
r/nutrition	"A place to discuss eating well."

As fitness trackers' ubiquity and popularity vary across time, it was deemed important that all of the subreddits covered the same period. As such, the corpus consisted of data from May 2015 (the earliest month in which all identified

subreddits were active) to January 2018 (the most recent month's data that were available when conducting the study).

4.2.2. Generation of search terms

Complete lists of the terms detailed below are provided in Appendix D. In line with the data pre-processing approach (subsection 4.2.3.), all terms are lowercase.

Fitness tracker terms

A list of nouns relating to fitness trackers was developed by consulting a comprehensive website of fitness wearables (inKin Social Fitness, 2017), Google Play 'Get Fighting Fit' and 'Get Outside' health and fitness app categories (Google Play, 2017), and previous literature relating to fitness trackers and eating disorders (e.g., Levinson et al., 2017). Generic terms (e.g., "fitness tracker") and other fitness trackers of theoretical interest (e.g., "cronometer") were also added.

Once this list had been developed, all multiword terms were added to the list of fitness tracker terms without whitespace (e.g., "fitbitsurge"). For single-word terms, each term was first entered separately into an internet search engine. In the case of multiword terms that corresponded to a brand/make (e.g., "fitbit") and model/app (e.g., "surge"), each term was also entered separately. For each separate term, if one or more of the top three search results related to the fitness tracker, it was deemed to have sufficient brand presence to be added to the list of fitness tracker terms on its own. Once the list of terms was compiled, any numeric values in the terms were removed (e.g., "couch25k" was translated into "couchk").

In all subsequent analyses, exact matches of the fitness tracker terms were sought. Therefore, as the terms represent nouns, singular and plural forms of each term were generated. First, the list of terms was reviewed, and irregular plurals – i.e., not created by only appending an "s" or "es" suffix to the singular form – were created on a case-by-case basis, and added as an additional term. For example, "bellabeatleaf" was pluralised to "bellabeatleaves". Two variations of each term were then generated, which represented two plural forms comprising the suffixes 's' and 'es' appended to the singular form (e.g., "fitbits"). This approach resulted in plurals that were not necessarily correct (e.g., "fitbites"). Despite this, the approach

was undertaken as it is more reproducible than manually reviewing the term list and removing any ostensibly incorrect plurals. In addition, commenters might not necessarily pluralise nouns correctly (e.g., “apple watchs”). As a result, the liberal approach used here also identified commenters’ incorrect plurals, which were viewed as being of equal semantic importance as correct plurals.

The resultant list included 169 unique fitness tracker terms. As detailed above, each term also had two additional plural forms (i.e., +“s” and +“es”), resulting in a total of 507 terms.

Recovery, eating, body and exercise-related terms

Three separate lists of terms were developed that related to either eating, the body or exercise. These terms were generated by compiling a list of all related terms taken from commonly used self-report measures. Eating terms (e.g., “calories”) were generated from the Eating Disorder Examination Questionnaire (EDE-Q; Fairburn, 2008) Restraint and Eating Concerns subscales, and the Shape and Weight Concerns subscales were used for body terms (e.g., “weight”). Exercise terms (e.g., “run”) were generated from the International Physical Activity Questionnaire (IPAQ; Craig et al., 2003) and CET (Taranis et al., 2011). For each identified term, several word forms were also generated (e.g., “exercise”, “exercises”, “exercised”, “exercising”). A list of five recovery terms was also generated comprising the term “recovery” and four related word forms.

4.2.3. Data extraction and pre-processing

The procedure undertaken to extract and pre-process the corpus is detailed in the following steps:

1) Using the freely available archive of *Reddit* comments (Complete Public Reddit Comments Corpus, 2018), all data from May 2015 to January 2018 (inclusive) were downloaded. For all the comments made on one of the six subreddits, the following information was extracted: month posted, author identifier, subreddit name, thread identifier, and comment text. Any comments created by the automated moderation bot (“AutoModerator”) were excluded. To avoid variations in capitalisation in the corpus, each

comment's text was translated into lowercase characters. The comment text was then pre-processed by removing the following: internet links, the phrase "[deleted]" (representing a comment deleted before archiving), punctuation, numeric characters, and common English stopwords, such as personal pronouns (e.g., "my"). In each comment's text, all occurrences of multiword fitness tracker terms were also concatenated by removing whitespace (e.g., "fitbit surge" was translated into "fitbitsurge").

2) The text of all comments that had the same subreddit name and thread identifier was then concatenated, which produced the corpus of pre-processed threads. Threads were selected rather than comments, as all comments in a thread correspond to the same initial post. Therefore, comments cannot be deemed to be independent, whereas threads can.

All data pre-processing was undertaken using the freely available natural language toolkit (Bird et al., 2009), and all code was written in *Python* programming language (Python Software Foundation, 2017).

4.2.4. Data analysis

The following steps were used to analyse the data:

1) Characteristics of the corpus and the subreddits were calculated (e.g., number of threads and commenters).
2) For the eating disorder subreddits, each thread containing at least one recovery term was counted, and the percentage of threads within each subreddit that referenced recovery was calculated. This method was repeated for each of the eating, body and exercise lists of terms for all six subreddits in the corpus.
3) The percentage of threads referencing fitness trackers was calculated for each of the six subreddits using the same method as detailed in the previous step. The same process was then used to calculate the percentage of threads within which each individual fitness tracker term occurred. After identifying the three most frequently mentioned fitness trackers across all six subreddits, all terms that occurred within the corpus that related to each specific tracker

were grouped (e.g., “mfp” and “myfitnesspal” for *MyFitnessPal*). Using the same method as in the previous step, these groups of terms were used to calculate the percentage of threads that referenced each fitness tracker.

4.3. Results

4.3.1. Corpus characteristics

For each of the six subreddits, descriptive statistics regarding the number of threads, comments and unique commenters, and the average number of comments made by each unique commenter are presented in Table 6.

Across all six subreddits, there were a total of 377,276 threads, 7,044,686 comments and 508,742 unique commenters. Each unique commenter posted on an average of one out of the six subreddits (*M*=1.08, *SD*=.30; median=1, range=1:6).

4.3.2. Mentions of recovery in eating disorder subreddits

Within the *r/proED* subreddit, 9.75% (3,640/37,335) of threads mentioned recovery, compared to 43.17% (825/1,911) of *r/fuckeatingdisorders* threads and 50.41% (486/964) of *r/EatingDisorders* threads.

4.3.3. Mentions of eating, body and exercise in all subreddits

Figure 6 presents separately the percentage of each subreddits’ threads that mentioned at least one term from each of the eating, body and exercise-related lists of terms.

Figure 6 indicates that eating was most frequently mentioned in *r/nutrition*, the body was most frequently mentioned in *r/loseit*, and exercise was most frequently mentioned in *r/Fitness*. *r/loseit* was also indicated to have the second highest proportion of threads mentioning both eating and exercise-related terms.

Table 6. Characteristics of the corpus

Subreddits	Number of threads	Number of comments	Number of unique commenters*	Average number of comments by each unique commenter*	
				Mean (*SD*)	Mean (*SD*)
Eating disorder					
r/proED	37,335	387,357	11,123	32 (104)	5 (1:2,722)
r/fuckeatingdisorders	1,911	10,637	1,809	6 (19)	2 (1:569)
r/EatingDisorders	964	4,991	1,774	3 (6)	1 (1:133)
Health-related					
r/Fitness	213,885	4,620,754	382,426	11 (121)	2 (1:47,835)
r/loseit	108,496	1,836,704	131,825	13 (123)	2 (1:21,160)
r/nutrition	14,685	184,243	22,847	8 (44)	2 (1:2,821)

*Excludes commenter '[deleted]'

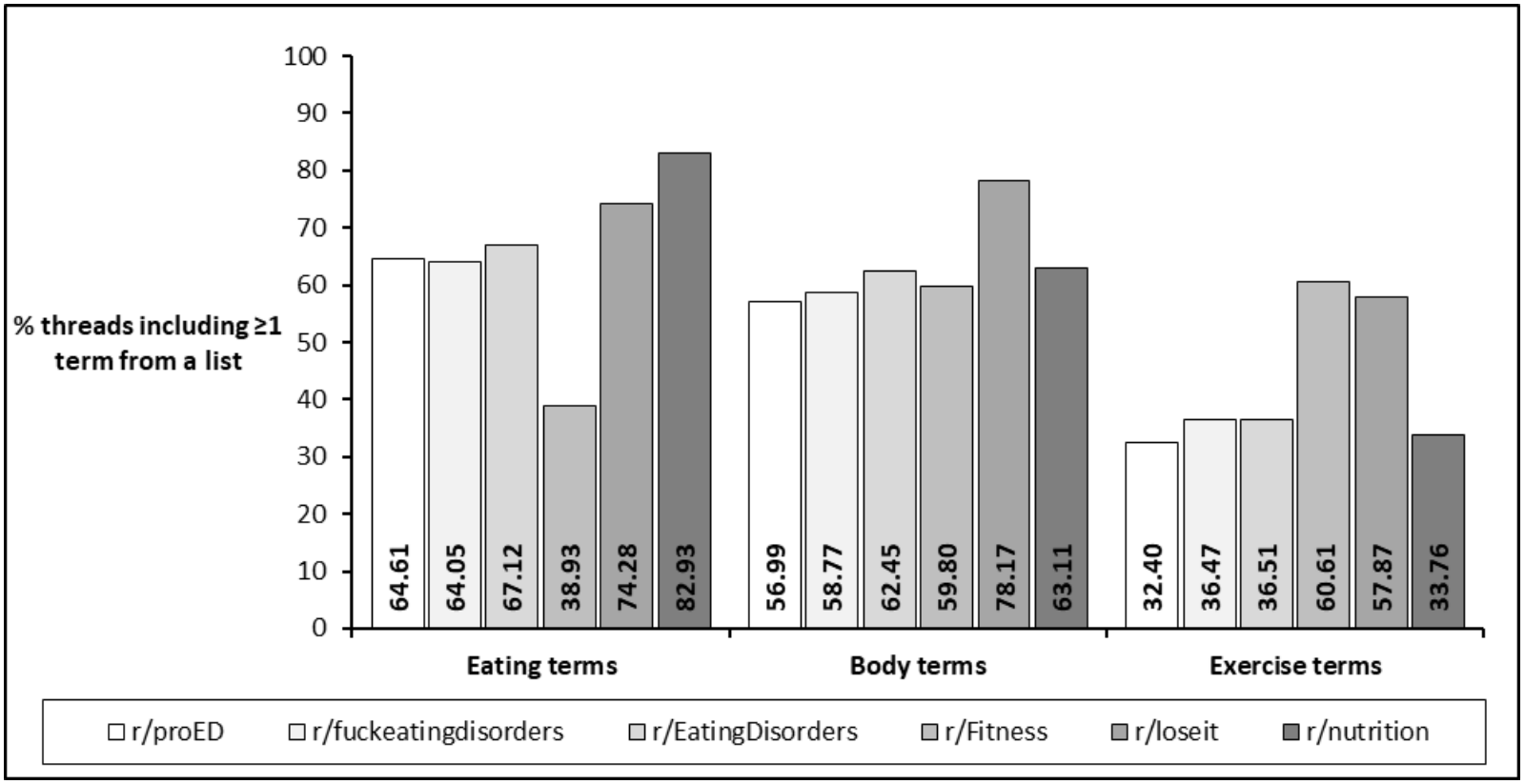

Figure 6. Percentage of threads including at least one term from eating, body and exercise-related lists of terms

4.3.4. Mentions of fitness trackers in all subreddits

Figure 7 presents the percentage of threads within a subreddit that contained one or more of the fitness tracker terms.

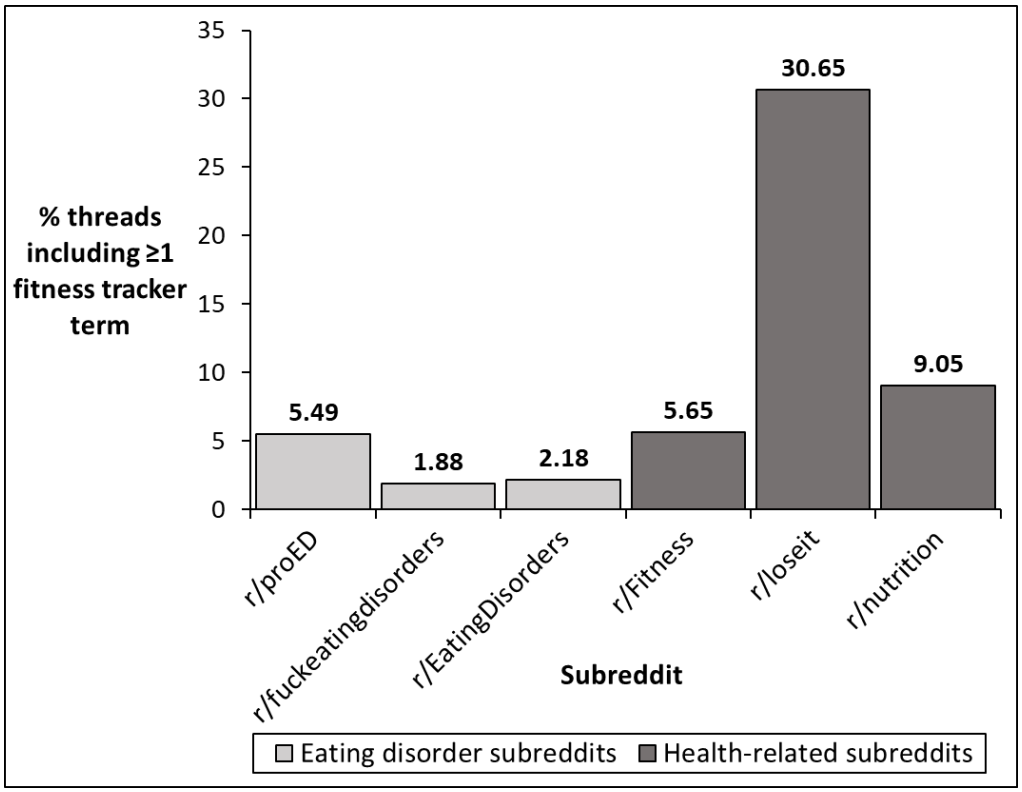

Figure 7. Percentage of threads including at least one fitness tracker term

Regarding the eating disorder subreddits, Figure 7 indicates that 5.49% (2,051/37,335) of threads within the *r/proED* subreddit contained a reference to a fitness tracker, which was greater than the other eating disorder subreddits, *r/fuckeatingdisorders* and *r/EatingDisorders* (1.88%, 36/1911 and 2.18%, 21/964, respectively). Regarding the health-related subreddits, *r/loseit* had a higher percentage (30.65%, 33,251/108,496) than *r/Fitness* and *r/nutrition* (5.65%, 12,081/213,885 and 9.05%, 1,329/14,685, respectively).

4.3.5. Frequently mentioned fitness trackers

The three most frequently mentioned fitness trackers within the corpus were identified. All of the terms that related to each identified tracker and occurred in the

corpus were grouped. Accordingly, the three identified fitness trackers were *MyFitnessPal*, *Fitbit* and Heart rate monitor. The terms relating to each fitness tracker are provided in Appendix D. Figure 8 presents the percentage of threads identified in subsection 4.3.4. that included at least one reference to each aforementioned fitness tracker.

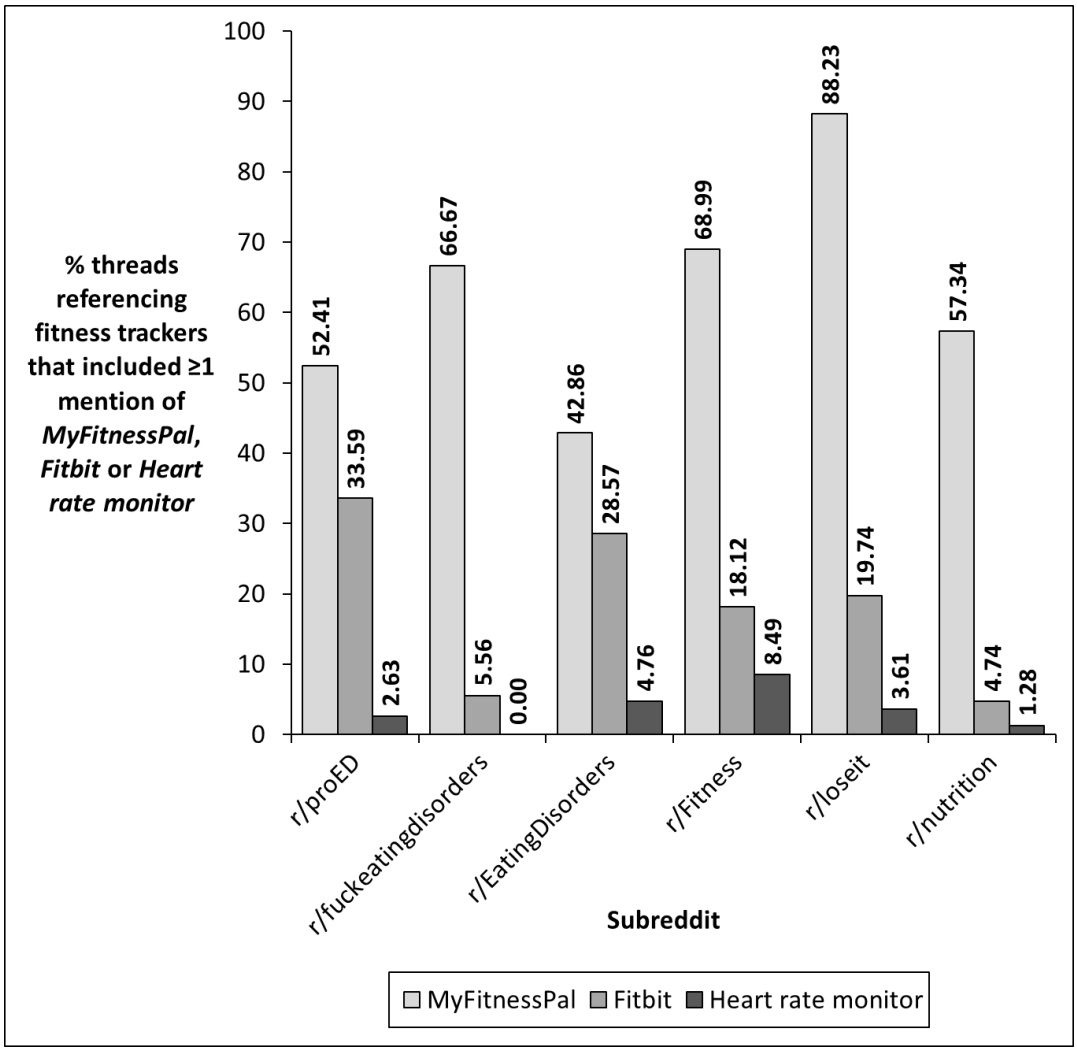

Figure 8. Percentage of threads referencing fitness trackers that included at least one mention of MyFitnessPal, Fitbit or Heart rate monitor

As shown in Figure 8, among the threads in which fitness trackers were mentioned, more than 40% included mentions of *MyFitnessPal*. This was true for all six subreddits, although such mentions were particularly prevalent in *r/loseit*.

4.4. Discussion

The study reported in this chapter applied text-mining to online content from *Reddit* to identify and quantify interest in fitness trackers in eating disorder subreddits, and to compare the contexts in which fitness trackers were most commonly discussed (i.e., pro-eating disorder, pro-recovery, fitness, weight-management, nutrition). Within the eating disorder subreddits, fitness trackers were most frequently mentioned in the least recovery-focused subreddit. Within health-related subreddits, the highest proportion of mentions was in the weight-management subreddit. Regarding specific fitness trackers, *MyFitnessPal* was the most frequently mentioned in all subreddits, and occurred in 40% or more of the threads that mentioned fitness trackers.

In the eating disorder subreddits, fitness trackers were more frequently mentioned in *r/proED*, than in *r/fuckeatingdisorders* or *r/EatingDisorders*. Approximately ten percent of *r/proED* threads mentioned recovery, compared to approximately half of the threads in *r/fuckeatingdisorders* and *r/EatingDisorders*. This finding suggests that *r/proED* is less recovery-focused than *r/fuckeatingdisorders* and *r/EatingDisorders*. Due to the more frequent mentions of fitness trackers in *r/proED*, this finding suggests that, while self-reported fitness tracker usage has been positively associated with eating disorder symptomatology (e.g., Hefner et al., 2016; Plateau et al., 2018; Simpson & Mazzeo, 2017), this relationship might be more nuanced. Rather, the association between fitness tracker use and these symptoms might be moderated by a person's focus on recovery. As fitness trackers were more frequently mentioned in the least recovery-focused subreddit (*r/proED*), the current findings are in line with previous survey-based research and interviews that indicated fitness tracker use to be more associated with the maintenance of eating disorders than recovery from them (e.g., Eikey & Reddy, 2017; Honary et al., 2019; Levinson et al., 2017; Tan et al., 2016). However, while the previous research investigated self-reported usage of fitness trackers, the current study focused on the mentions of fitness trackers. As

such, the findings from the current study might not directly compare to those from the previous research.

Within the health-related subreddits, fitness tracker terms were most frequently mentioned in the weight-management subreddit (*r/loseit*), which can be interpreted as a higher interest in fitness trackers in this community (cf. Walasek, Bhatia, & Brown, 2017). As *r/loseit* was indicated to be the health-related subreddit with the most frequent mentions of body terms, the findings suggest that fitness tracker interest is particularly high in people with a high interest in the body. This is in line with previous findings that fitness tracker use was positively associated with shape and weight concerns (Plateau et al., 2018; Simpson & Mazzeo, 2017). Undertaking exercise for weight-management (i.e., 'weight-control exercise') is a key dimension of compulsive exercise, and has been linked with shape and weight concerns in both community and clinical eating disorder samples (e.g., Noetel et al., 2016; Taranis et al., 2011). A positive association between overall compulsive exercise and use of apps (including fitness trackers) has also been observed (Hefner et al., 2016), although another study only reported an association between the CET weight-control exercise subscale and fitness trackers (Plateau et al., 2018). Taken together, these findings suggest that shape and weight concerns, weight-control exercise and fitness tracker use are potentially inter-related. Indeed, Plateau and colleagues (2018) found that self-monitoring physical activity for shape and weight-related reasons (compared to health, fitness or sporting reasons) was associated with higher levels of shape and weight concerns, restraint and weight-control exercise (Plateau et al., 2018).

Overall, fitness trackers were more frequently mentioned in the health-related subreddits than in the eating disorder subreddits, which could reflect a narrower content focus of the health-related subreddits. The current study also found that *MyFitnessPal* was the most mentioned fitness tracker in each subreddit, which supports a research focus on the usage of this particular fitness tracker in the context of eating disorders (Jospe et al., 2018; Levinson et al., 2017; Linardon & Messer, 2019). Additionally, commenters in *r/proED* were shown to have a higher average number of comments than commenters in *r/fuckeatingdisorders* and

r/EatingDisorders, which is in line with a finding that pro-eating disorder groups posted more frequently than pro-recovery groups (Teufel et al., 2013).

The example presented here supports the application of text-mining and word-frequency counts to complement more commonly used methodologies (e.g., surveys), as current findings appear to be in line with those previously obtained through survey-based measures (e.g., fitness trackers use more associated with eating disorder maintenance than recovery; Levinson et al., 2017; Tan et al., 2016). However, both the text-mining and survey-based findings require further validation, as the data obtained through these methods might not correspond actual fitness tracker use.

Limitations of the text-mining approach should be considered. First, homonymy (i.e., similarly spelled words with different meanings) and polysemy (i.e., one word with several meanings) are problematic for text-mining (Abbe et al., 2016). For example, "apple" could refer to the fruit or the brand of fitness tracker. As such, if "apple" had been included in the current research, the term could have inflated frequency counts. In order to mitigate this, terms that did not identify a fitness tracker in an internet search were excluded. A second general limitation is that naturally occurring language might include typographic errors or variations in spelling. As such, semantically relevant terms might not be identified due to these errors, although this risk was minimised by generating correct and incorrect plurals. Finally, the generation of terms might introduce an element of subjectivity into text-mining, and some fitness trackers might not have been identified. This subjectivity has been addressed by ensuring that the search terms were clearly detailed (enabling replication and extensions), and by only making relative comparisons across subreddits.

Text-mining is a rapid technique for identifying and extracting salient information, and can be used with any large corpus of text. As such, it offers several potentially beneficial applications for clinically relevant research. First, text-mining can facilitate the identification of groups that are potentially at-risk for eating disorders. As exemplified in the current research, an ostensibly pro-eating disorder community mentioned fitness trackers more frequently than pro-recovery communities. A

similar application of this technique could be applied to investigate group differences in eating disorder diagnostic criteria, such as purging or laxative use. Through identifying group differences, more targeted approaches could be introduced (e.g., screening, interventions). Similarly, this technique facilitates the generation and exploration of clinically relevant research questions for which there is little extant literature, or in populations who might otherwise be difficult to recruit. For example, the pro-eating disorder population might be difficult to recruit due to being characterised as non-recovery focused (cf. Branley & Covey, 2017).

4.5. Summary

Overall, the application of text-mining in this study provided support for the use of eating disorder-related content from *Reddit* in the development of the physical activity self-monitoring construct. Specifically, a total of 2,108 threads across the three eating disorder subreddits mentioned at least one fitness tracker term, with the majority of these being made on *r/proED* (97.30%). As this study quantified the frequencies with which fitness trackers were mentioned, it did not generate substantive evidence for the physical activity self-monitoring construct. As such, the next chapter details an extension of the current study, and reports research in which a sample of the textual comments identified in the current study were qualitatively analysed.

5. Study 3:

Insights into engagement with *MyFitnessPal* from online eating disorder forums

The study presented in this chapter has been published in the *International Journal of Eating Disorders* (McCaig, Elliott, Prnjak, Walasek, & Meyer, 2020). Consequently, the content presented in this chapter is adapted from the published article.

5.1. Introduction

As found in Study 2, eating disorder subreddits contain a large amount of textual data relating to fitness trackers. Consequently, content contributed to these online forums was indicated to be highly valuable for developing a conceptualisation of physical activity self-monitoring in relation to eating psychopathology. While the analyses in the previous chapter quantified the level of interest in fitness trackers, qualitative techniques are required to identify richer insights within the data. As such, the study reported in this chapter thematically analysed a sample of comments to generate comprehensive substantive evidence for the patterns of engagement with fitness trackers in this population.

Due to the heterogeneity between fitness trackers, the study focused on engagement with *MyFitnessPal*, as this represented a particularly important fitness tracker to investigate. First, it was the most commonly mentioned fitness tracker in the previously reported study (Study 2), as well as being the sole focus of three studies in the area of eating psychopathology (Jospe et al., 2018; Levinson et al., 2017; Linardon & Messer, 2019). Second, it is highly popular, and has been found to be the most downloaded calorie-counting and fitness-tracking app (Ferrara, Kim, Lin, Hua, & Seto, 2019). Last, while the use of *MyFitnessPal* for self-monitoring physical activity is central to its importance for the aims of this thesis, the app also facilitates the monitoring of one's diet. As such, focusing on *MyFitnessPal* (rather than a technology focused purely on fitness-tracking) also enabled the generation of qualitative insights into engagement with diet trackers in relation to eating psychopathology.

A previous study used a comparable approach by qualitatively analysing online comments that included eating disorder-related terms, and were made by 13 users

of an unspecified weight-loss app's forum (Eikey et al., 2017). The qualitative insights were grouped into positively and negatively perceived aspects of the app, such as providing a healthy or dangerous weight-loss plan, respectively. The approach used in the current study expanded on the approach used by Eikey and colleagues in three main ways. First, the current study ensured the relevance of the content to eating disorders by extracting comments from well-studied eating disorder forums, rather than a weight-loss app's forum. Second, the current study provides more comprehensive substantive evidence by greatly increasing the sample size, established through scoping the data for relevant content in the previously reported study (Study 2). Third, the current study focused on *MyFitnessPal*, which, as discussed, was important to consider for several reasons (i.e., popularity, focus of previous studies, supporting a wide range of functionality).

5.2. Methods

5.2.1. Corpus selection

The current study represents an extension of Study 2. As such, the previously written *Python* code (Python Software Foundation, 2017) was adapted to extract public comments posted on *Reddit* between May 2015 to January 2018 (inclusive) from a freely available archive (Complete Public Reddit Comments Corpus, 2018). In contrast to the previous study, the current data corpus was restricted to comments made on the three eating disorder forums (*r/proED*, *r/fuckeatingdisorders*, *r/EatingDisorders*; Table 5), and comments were only extracted that included an explicit reference to *MyFitnessPal*, which constituted the use of at least one of the following terms: 'mfp', 'fitness pal', or 'fitnesspal'. The University of Warwick's Biomedical and Scientific Research Ethics Committee granted ethical approval for the current study (REGO-2019-2366).

5.2.2. Data analysis

The data corpus was thematically analysed using Braun and Clarke's (2006) six-step guide as a reference. In brief, after reading through the comments to become familiar

with the data (step 1), an initial set of codes was developed, with each code representing a meaningful aspect of the data (e.g., a pattern of engagement, an emotional consequence; step 2). The qualitative software *NVivo* (QSR International Pty Ltd., 2018) was used to facilitate this initial coding. Codes that were similar in meaning were then grouped (step 3), and these groups were subsequently revised to create the themes and subthemes (step 4). Finally, the themes and subthemes were labelled and defined (step 5), and the analysis was formalised in the production of this report (step 6). An inductive approach to the thematic analysis was used due to the exploratory nature of the research, and a critical realist perspective was adopted focusing on themes at the semantic level – i.e., the commenters' experiences were of interest, and were considered to be explicit within their comments.

Throughout all steps in the thematic analysis, the author of this thesis conducted the analyses, and four other researchers acted as 'critical friends' (e.g., Smith & McGannon, 2017; Smith & Sparkes, 2006). In this role, the critical friends challenged and offered alternatives to the author's coding and interpretations, which facilitated reflexivity in the analysis, and ensured that the final thematic structure was rigorous and coherent. In line with current ethical guidance for internet-based research (cf. British Psychological Society, 2013; Williams et al., 2018), quotations provided in this report have been paraphrased to prevent identification of individual commenters, and are brief and used sparingly.

5.3. Results

5.3.1. Corpus characteristics

In total, 1,695 comments including at least one reference to *MyFitnessPal* were made on the three eating disorder forums between May 2015 and January 2018, inclusive. Specifically, 1,644 (97%) comments mentioning *MyFitnessPal* were made on *r/proED*, compared to 15 (1%) on *r/EatingDisorders* and 36 (2%) on *r/fuckeatingdisorders*. Overall, the comments were made by 920 commenters, who made on average

(mean) 2 comments each that mentioned *MyFitnessPal* (*SD*=2, median=1, minimum=1, maximum=27). The entire corpus consisted of 157,278 words, and the average (mean) length of a comment was 93 words (*SD*=105, median=59, minimum=1, maximum=1,281).

5.3.2. Themes

Overall, three themes were identified: *Preventing misuse*, *Accuracy*, and *Psychosocial factors*. Each theme comprises subthemes, which are summarised in Table 7.

Table 7. Themes and subthemes concerning engagement with MyFitnessPal

Theme	Subtheme	Description
Preventing misuse	Interventions	Interventions implemented by *MyFitnessPal* aimed at preventing use in people who pursue underweight goals, severely limit energy-intake, or endorse 'pro-eating disorder' ideals (i.e., encourage eating disorders)
	Circumventing interventions	Ways in which people change their engagement with *MyFitnessPal* in response to its interventions
Accuracy	Inaccuracy	Distrust in the accuracy of *MyFitnessPal*
	Improving accuracy	Ways in which people improve *MyFitnessPal*'s accuracy
	Deliberate misrecording	Deliberate misrecording to allow room for error (e.g., *MyFitnessPal*'s inaccuracy, perceived goal violations)
Psychosocial factors	Cognition and affect	Cognitions and affect that influence, or are influenced by, the use of *MyFitnessPal*
	Behaviour	Behaviours that are influenced by the use of *MyFitnessPal*, and their associated outcomes (e.g., weight)
	Interpersonal factors	Interpersonal factors associated with using *MyFitnessPal*

Preventing misuse

The theme *Preventing misuse* comprises two subthemes: *Interventions* and *Circumventing interventions*. *Interventions* describes measures that *MyFitnessPal* have ostensibly implemented to intervene if its users demonstrate symptoms associated with eating disorders. As illustrated in the following quotation, commenters indicated experiencing the measures if they: recorded a daily calorie-intake below a minimum (with 1,000kcal, 1,200kcal, or a male-specific amount of 1,500kcal being reported); were underweight; had an underweight or extreme weight-loss goal; were known or reported to have an eating disorder; or contributed content that encourages eating disorders to *MyFitnessPal* (e.g., creating a 'pro-eating disorder' forum).

> "*MFP* will notify you if you eat fewer than 1200 calories, or have an extreme weight-loss goal" (commenter 725)

The nature of the interventions were indicated to vary, including notifications that users had recorded low daily calorie- or nutrient-intake, or that their weight was too low. Interventions restricting use included: not recording a day's data; not providing a weight-loss prediction; and banning users, suspending or deleting their account, and directing them to an eating disorders 'crisis' website. Despite violating some of the limits (e.g., daily calorie-intake under 1,000kcal), other commenters reported not experiencing any of the interventions, which was suggested to be due to using an older or less common version of the app (e.g., on a 'tablet' device).

Perhaps reflecting negative views of the interventions (e.g., 'punitive', 'judgemental', 'abusive'), commenters discussed how they could circumvent these measures (*Circumventing interventions* subtheme). Commenters reported altering specific characteristics, with men entering that they are women to have a lower minimum daily energy-intake, and others altering their height to enable a lower actual weight or weight-loss goal. On a more daily basis, the commenters indicated being able to record their actual energy-intake if they did not formally 'complete the day'. Alternatively, commenters recorded extra energy-intake to meet the minimum, with some labelling the additional calories as fake (e.g., 'padding', 'false', 'ghost calories'),

and others keeping a physical record of their actual energy-intake to compare to their *MyFitnessPal* data (e.g., in a 'notebook'). Commenters also described offsetting or correcting the additional energy-intake by adding an equivalent amount of energy-expenditure (e.g., exercise) or adding the extra energy-intake, then completing the day before deleting the extra calories. Regarding the notifications, some commenters mentioned ignoring these or disabling 'pop-up messages', while one commenter changed their device's colours to greyscale so that the notifications were less salient. Others did not use *MyFitnessPal*'s associated forums, so that they were not discovered or reported to have an eating disorder. Last, many commenters simply stated that they used a different app or device that did not have the same interventions, as exemplified in the following quotation:

> "I use *Lose It!* instead of *MFP* as I can enter any goal I want, and it doesn't shout at me if I don't eat a lot." (commenter 128)

Accuracy

The theme *Accuracy* comprises three subthemes: *Inaccuracy*, *Improving accuracy* and *Deliberate misrecording*. *Inaccuracy* details commenters' distrust in the accuracy of *MyFitnessPal*. While some commenters expressed distrust generally, others did not trust certain functionality. Specifically, calorie-content estimates of food and drink were seen to be inaccurate, with suggestions that: *MyFitnessPal* underestimates the calorie-content; there are discrepancies in estimates for the same item; and food and drink packaging does not match the entries in *MyFitnessPal*. The main reason for this distrust was seemingly due to the fact that anyone can create an entry for an item of food or drink in *MyFitnessPal*'s public database. Other functionality described as inaccurate were energy-expenditure estimates (see quotation below), which were viewed as overestimates and unreliable over time, and weight-loss or weight-maintenance predictions.

> "*MFP* overestimates calories burnt more than any other app. I wouldn't trust it." (commenter 192)

Several ways of improving *MyFitnessPal*'s accuracy were described, represented by the *Improving accuracy* subtheme. Regarding energy-intake, commenters ensured

calorie-content estimates were as accurate as possible by comparing estimates to more trustworthy sources of information (e.g., packaging, governmental agencies), always creating their own estimates, and avoiding unverified entries in *MyFitnessPal*'s database. Some commenters also mentioned using a food scale to ensure the quantities of food or drink they entered were accurate. Similarly, the energy-expenditure estimates were reportedly improved by syncing *MyFitnessPal* with a more accurate device, as exemplified in the quotation below. Some commenters also described reviewing weekly or average data, as they saw this information as more accurate than daily results (i.e., minimising the impact of days that were outliers).

> "I sync my *Fitbit* with *MFP* so I can get more accurate energy-expenditure" (commenter 78)

Deliberate misrecording describes strategies the commenters reported using to account for inaccuracy in *MyFitnessPal*, or their own perceived transgressions (e.g., overeating, underexercising). Such strategies included deliberately overestimating their energy-intake or weight, or underestimating their energy-expenditure. Concerning overestimating energy-intake, commenters detailed recording the meal they were going to eat, but then deliberately not eating all of it. Some stated that, if they exceeded their daily energy-intake, they added the excess to the following day. However, others reported not recording excess energy-intake or episodes of binge eating, or entering a set amount of energy-intake for a binge eating episode rather than tracking it accurately. Additionally, as illustrated in the following quotation, commenters described underestimating or not recording energy-expenditure or purges, viewing any calories expended through these behaviours as a 'plus'.

> "*MFP* overestimates my energy-expenditure, so I halve the time I'm active when I record it." (commenter 544)

Psychosocial factors

The theme *Psychosocial factors* comprises three subthemes: *Cognition and affect*, *Behaviour*, and *Interpersonal factors*. *Cognition and affect* describes thoughts and feelings that influence, or are influenced by, the use of *MyFitnessPal*. As shown in the

following quotation, commenters indicated that recording energy-expenditure or deleting energy-intake (e.g., if planned calorie-intake was not consumed) improved their mood, and described more positive experiences the better their progress was regarding their goals (e.g., 'satisfied', 'in control', 'reassured').

> "Even though I ignore calories burnt, I'll add more steps in, too. It's great to see the calories taken off." (commenter 442)

Some commenters also indicated that they felt satisfied when they received a notification that their energy-intake was too low. Planning energy-intake or prerecording calorie-content before consumption was described as making the commenters feel more relaxed, and able to stop thinking about food or drink. Using *MyFitnessPal* also reportedly helped alleviate negative experiences (e.g., 'stressed', 'anxious'), particularly when estimates were perceived as accurate. However, some commenters reported not using *MyFitnessPal* to avoid negative feelings associated with its use (e.g., 'stress', 'worried', 'guilt'), which they described experiencing when they violated their goal by as little as one calorie, or even when they achieved their goal. Others also felt judged by *MyFitnessPal*'s standard functionality, such as notifications of consuming too much of a specific nutrient (e.g., fat). *MyFitnessPal* was reported to result in a greater awareness of the nutrient- or calorie-content of food and drink, with commenters explaining that they used it when starting a diet to learn about nutrient and calorie content or requirements, or that they stopped using it when they knew this information. The app was also seen to aid motivation, such as feeling 'accountable' to something, but it was also suggested to increase competitiveness with oneself and others. Several commenters, including some who indicated being in recovery from eating disorders, reported feeling addicted to *MyFitnessPal*, and felt it contributed to overthinking about calories and food, and ruminating on binge eating episodes.

The *Behaviour* subtheme represents behaviours that are influenced by the use of *MyFitnessPal*, and related outcomes. The app was indicated to assist in restricting energy-intake, preventing overeating and binge eating, and interrupting the binge eating-purge cycle. Similarly, non-use was mentioned by some to trigger overeating. The assistance in restricting energy-intake reportedly resulted from *MyFitnessPal*

helping them not to eat without thinking about calorie or nutritional content, with the habit of prerecording food or drink in the app (i.e., calculating its content before ingestion) indicated to be particularly helpful. Resulting from *MyFitnessPal*'s effect on behaviour, some commenters suggested that it facilitated a reduction in body size, shape and weight. However, others reported that the app did not assist restriction, and triggered purging, and overeating or binge eating, particularly when they had remaining calorie-intake for a day (i.e., calorie-intake was below their allowance). Due to *MyFitnessPal*'s influence on eating disorder-related behaviours, commenters mentioned avoiding or deleting *MyFitnessPal* in recovery (see following quotation), and expressed that its use facilitated relapse.

> "I don't weigh food or use *MyFitnessPal* any more, as I'm trying to recover." (commenter 86)

The subtheme *Interpersonal factors* represents social factors associated with using *MyFitnessPal*. Using its social functionality, commenters reported adding other people on the app, meaning others could view their data. While commenters mentioned adding friends and family, they also shared their usernames in the *Reddit* eating disorder forums, so they could connect with members of these online communities on *MyFitnessPal*. While *MyFitnessPal*'s own forums were mentioned, they were described as being a platform for people to criticise others for their performance or lack of self-control. In contrast to being open about their use of *MyFitnessPal*, some commenters made their diary private to stop others from viewing their data, and, more generally, described concealing their habits of using the app from their friends and family (e.g., pretending to use a different app), as illustrated in the following quotation:

> "If someone asks me what I'm doing when I'm on *MFP*, I just say that I'm 'on *Reddit*' or 'texting someone'." (commenter 132)

5.4. Discussion

The study reported in this chapter aimed to provide comprehensive qualitative insights into engagement with a popular fitness (and diet) tracker, *MyFitnessPal*, as described by commenters on online eating disorder forums. By thematically analysing a large sample of 1,695 comments from eating disorder forums that mentioned *MyFitnessPal,* contributed by 920 commenters, three themes were generated – *Preventing misuse*, *Accuracy*, and *Psychosocial factors*. In addition to identifying patterns of engagement with fitness and diet trackers, the themes also expanded on previous findings of psychosocial factors that influence and result from using these devices and apps.

The theme *Preventing misuse* described several interventions that were ostensibly implemented by *MyFitnessPal* to address pathological use, and ways in which commenters reported circumventing its interventions. While Levinson and colleagues (2017) mentioned notifications of low calorie-intake, *MyFitnessPal* also reportedly intervenes in other ways if a user is suspected of having an eating disorder. For example, the app appears to limit its functionality in such users (e.g., preventing the recording of data, not providing weight-loss predictions), or ban them and delete their accounts. However, the interventions appear to be inconsistently applied, or are easy to circumvent, such as by simply using a different app or device. The use of alternative technology parallels findings concerning pro-eating disorder content, which indicated that banned 'hashtags' (i.e., ways of flagging content to other interested users) were simply replaced with new ones (Gerrard, 2018). While a change in policy could mandate the inclusion of interventions in commercially available calorie counters and fitness trackers, this approach would potentially be ineffective as older versions would still be available, or motivated users could create their own. As such, there is a need for researchers and companies to take shared responsibility for developing and implementing more effective interventions in these technologies. To prevent users from disengaging and using a different app or device, interventions could potentially be more effective if they are subtle, so that they are not viewed as 'punitive', 'judgemental', or 'abusive'. Such interventions could involve the provision of psychoeducation to current users (cf. Levinson et al., 2017), as,

currently, *MyFitnessPal* only appears to provide this information to users whom it bans.

The *Accuracy* theme described a reported distrust in the accuracy of various aspects of *MyFitnessPal*'s functionality, and several ways in which the commenters reported reducing this inaccuracy. Of concern, the commenters also reported deliberately misrecording their data to create 'room for error'. Supporting previous findings (Eikey & Reddy, 2017), the commenters in the current study indicated underestimating their energy-expenditure, or not recording this information or purges, instead viewing any calories expended as a bonus. Such a finding is in line with patients with anorexia nervosa tending to underreport their amount of exercise (Bezzina et al., 2019; Bratland-Sanda et al., 2010). As well as underestimating energy-expenditure, commenters reported overestimating their energy-intake, using heuristics (e.g., a set calorie-content for a binge eating episode), or pre-recording energy-intake but planning not to consume it. Taken together, the findings suggest a degree of self-deception in how users engage with *MyFitnessPal*, with deliberate misrecording seemingly in a direction that facilitates weight-loss (i.e., overestimating energy-intake, underestimating energy-expenditure). Due to the potential self-deception, improving the accuracy of calorie-counting and fitness-tracking technologies might have a minimal effect on these behaviours. Tentative evidence supports improved accuracy having little effect, as, compared to people with low dietary restraint, the energy-intake of more highly restrained people is less influenced in the short-term by energy-expenditure feedback (McCaig et al., 2016).

Last, psychosocial factors that reportedly influence, or are influenced by, engagement with *MyFitnessPal* were identified. As with previous findings (Eikey & Reddy, 2017; Eikey et al., 2017), there was variability in whether commenters viewed engagement as facilitating or worsening psychosocial factors, such as negative feelings (e.g., 'stress'), and eating disorder-related behaviours and outcomes (e.g., restricting, weight-loss). Such heterogeneity suggests moderators in the relationship between engagement with calorie-counting and fitness-tracking technologies, and eating disorder-related symptomatology, which could explain the inconsistencies in previous research (Embacher Martin et al., 2018; Hefner et al., 2016; Plateau et al.,

2018; Simpson & Mazzeo, 2017). As suggested in the previous chapter, a user's focus on recovery is potentially a key moderator in this relationship, as the current and previous findings (Eikey & Reddy, 2017; Honary et al., 2019) suggest that people in recovery alter their use of calorie-counting and fitness-tracking technologies (e.g., deleting the app). The current findings also emphasise the potential importance of perfectionistic, dichotomous and obsessive thinking styles in this context, as suggested by previous researchers (e.g., experience anxiety if exceed goal by one calorie; Eikey & Reddy, 2017; Levinson et al., 2017; Linardon & Messer, 2019; Simpson & Mazzeo, 2017). Last, in addition to supporting findings that users viewed *MyFitnessPal* as increasing competitiveness with oneself (Eikey & Reddy, 2017), commenters in the current study also viewed it as increasing their competitiveness with others. Together with the observation in this study that people exchanged their *MyFitnessPal* usernames on the *Reddit* forums, the higher competitiveness with others could facilitate members of pro-eating disorder online communities encouraging each other's pathological behaviours.

Regarding the limitations of the current study, it is not possible to characterise the commenters on eating disorder forums in terms of their type or degree of eating disorder symptomatology. A potential way to overcome the limitation in the sampling and design of the current study would be to ask commenters on the eating disorder subreddits to complete measures of eating disorder symptomatology (e.g., EDE-Q) and other factors (e.g., demographics). The content contributed by these commenters could then be analysed in relation to their characteristics (e.g., gender, level of eating disorder symptomatology). More generally, future research is required to investigate whether varying diagnoses and levels of eating pathology are related to different patterns of engagement with *MyFitnessPal*. A limitation of the data extraction method is that it is possible that relevant content that referred to *MyFitnessPal* with a pronoun (e.g., 'it') rather than one of the search terms ('mfp', 'fitness pal', 'fitnesspal') was not identified. However, the effect of this limitation is mitigated by the large sample size. Last, the study focused on *MyFitnessPal* and, consequently, the conclusions cannot be applied uncritically to similar devices and

apps. However, due to *MyFitnessPal* supporting both calorie-counting and fitness-tracking, the findings might also apply to technologies with the same functionalities.

The qualitative insights obtained in the current study have several implications for future research. First, the findings can be used in the development of a standardised measure of engagement with calorie counters and fitness trackers in relation to eating psychopathology. Specifically, the insights can guide the generation of a set of items, which can then be subjected to structural and external validity testing (cf. Flake et al., 2017). While previous self-report items assess a narrow conceptualisation of engagement (e.g., assessing use dichotomously; e.g., Simpson & Mazzeo, 2017), the current findings outline other patterns of engagement that should be assessed (e.g., recording calories that are not actually consumed), and indicate ways in which existing self-report items might be improved. For example, pre-recording calorie-containing items before consumption was identified as a potentially important pattern of engagement in people with high levels of eating psychopathology. However, if such pre-recording is characteristic of someone who has, on average, few daily eating episodes (i.e., is restricting), this pattern of engagement could explain the previously observed lack of an association between the frequency of calorie-counter use and eating disorder symptomatology (Plateau et al., 2018). In contrast, such an association might be found if assessing the consistency of self-monitoring, rather than the frequency – e.g., 'When you consume calories, how often do you use a calorie-counting application or device?' ('Never' to 'Every time' response options). Through developing a more valid, quantitative measure of engagement, the degree to which each aspect of engagement is associated with eating disorder-related factors (e.g., symptoms, diagnoses, recovery-focus) could be assessed. If an aspect of engagement were identified as indicative of a factor (e.g., a specific symptom), intervention content could be tailored to the factor, and then targeted at users displaying the related pattern of use. More generally, future research should investigate the causal relationships between the aspects of engagement and psychosocial factors identified in the current study. For example, whether higher dietary restraint *leads to* overestimating energy-intake, *is a result of* overestimating energy-intake, or both.

5.5. Summary

Overall, through using an inductive (i.e., bottom-up') approach, the current study found support for engagement with fitness (and diet) trackers being a multifaceted construct. Future research investigating fitness tracker use in relation to eating psychopathology should therefore consider and assess the breadth of engagement with this technology. However, while the study reported in this chapter provides qualitative insights into engagement with fitness trackers, these devices and apps represent only one form of physical activity self-monitoring. Consequently, an understanding of the other forms (and focuses) of physical activity self-monitoring is a necessary consideration for the broader construct. Therefore, the next chapter describes a large-scale survey that aimed to develop a comprehensive understanding of the variety of forums and focuses of physical activity self-monitoring.

6. Study 4:

Forms and focuses of physical activity self-monitoring

6.1. Introduction

The previous two studies (Studies 2 and 3) focused on the interest in, and engagement with fitness trackers reported by commenters on online eating disorder forums. Due to existing research in this area tending to focus on the use of these technologies in relation to eating psychopathology, the findings presented in the previous two chapters can inform future research that follows this line of enquiry. However, fitness trackers represent only one form of physical activity self-monitoring, with other forms including recording one's exercise on paper records, or simply remembering it (e.g., Abril, 2016). Similarly, people might focus on different attributes when monitoring their physical activity, such as the distance they have run, or the number of stairs they have climbed (e.g., Lyons et al., 2014).

Without considering the broader forms and focuses of physical activity self-monitoring, important factors affecting the construct's relationship with eating psychopathology might remain unassessed. As such, if forms and focuses are not sufficiently considered when designing a study, the findings could be confounded and limit the conclusions that can be made. As previously outlined, this is exemplified by an experimental study (Conroy et al., 2011) in which the manipulation of self-monitoring across two conditions varied in both its form (paper compared to digital) and physical activity-related focus (duration compared to duration, intensity, type, steps, resistance and repetitions). As a result, the conclusions made by Conroy and colleagues about digital self-monitoring having a greater effect on behaviour were confounded by the different focuses. However, as reported in a meta-analysis of intervention studies (Harkin et al., 2016), different forms of physical activity self-monitoring are indicated to vary in their effectiveness in influencing behaviour, further supporting the importance of considering a broader range of forms and whether they are differently related to eating psychopathology.

While reviews have consolidated this range of forms and focuses of physical activity self-monitoring to some extent, such research is necessarily limited in scope. For example, the reviews have focused on forms used within intervention studies (Harkin

et al., 2016), or identified monitored aspects that wearable devices can measure (Lyons et al., 2014). In order to address these limitations, the aim of the study reported in this chapter was to investigate comprehensively the range of forms and focuses of physical activity self-monitoring. To achieve this, a large and diverse sample was recruited, and the participants were asked to describe all the ways in which they monitored their physical activity. The participants' responses were then analysed using an inductive thematic analysis to present a comprehensive overview of the ways in which physical activity self-monitoring can be enacted.

6.2. Methods

6.2.1. Participants

The opportunity to participate in this survey was advertised widely in order to capture the range of normal to abnormal experiences of physical activity self-monitoring. In order to capture this range, the study was advertised widely using print and online advertisements. Moderators on several social media platforms (i.e., *Twitter*, *Facebook*, *Reddit*) were asked about the possibility of advertising the study on their group or forum. Moderators from over 100 groups relating to a variety of topics (e.g., food, sport, mental health) were approached, with approximately 40 agreeing to advertise and promote the study. Additionally, to capture a diverse sample, few eligibility criteria for participation were set, except for being 18 years old or over, fluent in English, and not currently pregnant.

Participation in the study was not financially incentivised, and the study was granted ethical approval by the University of Warwick's Biomedical and Scientific Research Ethics Committee (REGO-2017-2112 AM01).

6.2.2. Procedure and measures

The survey was hosted online using *Qualtrics* (2005). Following their provision of informed consent, all participants completed a set of self-report questions. The responses from these questions were used to describe the sample, and to identify people who indicated an interest in participating in an interview and had a high level

of compulsive exercise (Study 5). The variables assessed by the self-report questions included: demographics, such as age, gender, height and weight; aspects of physical activity, including compulsive exercise (assessed with the CET; Taranis et al., 2011), amount of activity (assessed with the International Physical Activity Questionnaire; Craig et al., 2003), and sporting background; and aspects of eating psychopathology, such as levels of eating disorder symptomatology (assessed with the EDE-Q; Fairburn, 2008), experience of eating disorder treatment and diagnosis, and levels of body checking (assessed with the BCQ and MBCQ; Hildebrandt et al., 2010; Reas et al., 2002).

Following completion of the self-report measures, participants were asked to complete a sentence-completion task regarding the ways in which they monitor and keep track of their physical activity. Participants were presented with the following instructions: “For this question, we would like you to complete the sentence below to describe all of the ways in which you monitor and keep track of your physical activity. Please use a new line for each way in which you monitor and keep track of your physical activity. Please think of all areas of your life, such as at work, college or university, getting from one place to another, around the house, and in your free time (e.g., exercise).” Participants were then provided with the sentence-stem “I monitor and keep track of my physical activity by…”, and a text-entry box in which they could enter their response. Participants were able to enter as much or as little text as they wanted. Participants who had not completed this question (i.e., left the section blank) were excluded from the subsequent analyses.

6.2.3. Data analysis

In order to describe in detail the ways in which people monitor and keep track of their physical activity, all responses to the physical activity sentence-completion task were compiled, and the resulting corpus of text was thematically analysed (Braun & Clarke, 2006; Braun et al., 2016). More specifically, this analysis was inductive in nature, adopted a critical realist perspective, and focused on themes at the semantic level. In practice, the inductive (i.e., 'bottom-up'; Patton, 1990) approach provided the flexibility to identify previously unconsidered themes (i.e., specific forms and focuses of physical activity self-monitoring). Furthermore, the consideration of

semantic level themes maintained a focus on themes that were explicit in the participants' responses and did not require a deeper level of analysis.

During the analytic process, a six-step guide was used as a reference (Braun & Clarke, 2006). As the survey responses were text-based and collected online, the first step comprised reading through the responses to become familiar with the data, and noting ideas while undertaking this process. The data were then imported into *NVivo* software (QSR International Pty Ltd., 2018), which facilitated the generation of initial codes by considering each response in turn. Once this process had been completed for the entire corpus of text, the list of codes were used to develop themes, which were then refined, defined and named. Finally, the analysis was formalised in the report presented in this chapter. In order to ensure rigor in the analytic process, four other researchers acted as 'critical friends' to encourage reflexivity in the author's analysis (e.g., Smith & McGannon, 2017).

6.3. Results

6.3.1. Sample characteristics

A total of 3,698 participants completed the online survey, of which 203 were excluded as they had left the sentence-completion question blank. As a result, the subsequent analyses are based on a sample of 3,495 people.

In summary, most participants (72%) identified as female and were assigned female at birth, and the sample had a mean age of 28 years (*SD*=7) and body mass index of 24 units kg/m2 (*SD*=5). The majority of participants were from the USA or Canada (65%), white (85%) and in full-time employment (65%). Regarding physical activity, participants walked, for at least 10 minutes a day, on a mean of 5 days a week (*SD*=2), and were moderately and/or vigorously active on a mean of 3 days a week (*SD*=2). On average, the sample fell below clinically-relevant cut-offs for levels of compulsivity towards exercise (i.e., *M*=13, *SD*=3 vs. cut-off of 15; Meyer et al., 2016), and approximately 50% had either currently or previously competed in sport, most of these at school or club level. The sample's mean score relating to eating disorder

symptomatology was below a cut-off for eating disorders screening in the community (i.e., *M*=2.0, *SD*=1.4 vs. cut-off of 2.3; Mond, Hay, Rodgers, Owen, & Beumont, 2004), and body checking scores were, on average, low to moderate. Over 10% of the sample reported current or previous experience of eating disorders, with the majority of these indicating a diagnosis of either anorexia nervosa or eating disorder not otherwise specified. Last, for the sentence-completion task, participants responded with a mean of 16 words (*SD*=20), and a median of 11 words (ranging from 1 to 346 words). A detailed description of the sample is provided in Appendix E.

6.3.2. Themes

The analysis resulted in the identification of three themes, which were named: *Focus*, *Self-monitoring* and *Comparing*. All three themes are now described in turn, and are presented along with their respective subthemes in Table 8. All subsequent terms in inverted commas are examples of terms or phrases used by respondents.

Table 8. Themes and subthemes relating to forms and focuses of physical activity self-monitoring

Theme	Subtheme	Description	Examples
Focus	Physical activity	Monitored aspects of physical activity	type, quantity, duration, framing
	Physiology	Monitored aspects of physiological processes	energy levels, effort, heartrate, breathing
	Physique	Monitored aspects of one's physique	fat, muscle, arms, stomach, size
	Ingestion	Monitored aspects of ingestive behaviour	calorie-intake, fast periods, meals, protein
	Physical and mental state	Monitored aspects of one's general physical and mental state	fitness, illness, mood, motivation, concentration
Self-monitoring	Mental and sense-based monitoring	Self-monitoring techniques that rely on mental processes or senses	remembering, mentally keeping track, listening to one's body, counting
	Instrumental monitoring	Self-monitoring techniques that necessitate the use of an instrument	timing exercise, recording exercise, using a pedometer
Comparing	Reference value	Target against which self-monitored state is compared	time in the past, other specific people, benchmarks for age and sex
	Comparative process	Comparisons between the focus of self-monitoring and a reference value	burn more calories than eaten, compare exercise to previous week
	Evaluation of comparative outcome	Subjective outcomes of comparisons	satisfaction, successful, disappointed

Focus

The theme *Focus* consolidated the features that the participants reported self-monitoring, comparing or holding as reference values. These features were grouped into five subthemes based on the nature of each, and were named: *Physical activity*, *Physiology*, *Physique*, *Ingestion*, and *Physical and mental state*.

The following quotation exemplifies the *Physical activity* subtheme, which comprised features that related directly to the behaviour of being physically active.

> "Using a Fitbit (fitness tracker) to monitor number of steps and amount of exercise" (participant 147)

Respondents commonly referred to their physical activity in general terms (e.g., 'my physical activity', 'weekly exercise'), or specified the type of activity (e.g., 'lifting', 'yoga', 'crossfit', 'climbing'). Activity was typically described as bouts (e.g., 'fitness classes', 'workouts', 'runs'), or parts of bouts (e.g., 'reps', 'sets', 'laps'). Respondents also often indicated a general quantification of their activity (e.g., 'stats', 'metrics', 'numbers'). Specific forms of quantification related to different features of activity on which the respondents focused. These included the amount of activity (e.g., 'the volume (number of sets/reps)'), its duration (e.g., 'how long I can hold planks', 'minutes of cross-training'), its frequency (e.g., 'how often I am exercising', 'how many times I work out per week'), the distance covered (e.g., 'my weekly mileage'), speed (e.g., 'pace', 'how fast […] I walk'), verticality (e.g., 'how many floors climbed'), power output (e.g., 'watt output'), and weight used as part of an activity (e.g., 'weights measured in kg'). Last, the framing of activity varied, such as whether exercise was described as 'training' or 'non-training', or whether it was 'casual' or 'formal'. Intensity-related terms were also used to frame activity (e.g., 'easy', 'strenuous'), as were terms concerning how intentional the activity was (e.g., 'deliberate', 'incidental').

Features within the *Physiology* subtheme represented physiological processes, or sensations that related to these. Such focuses are illustrated in the following quotation:

> "Seeing how my energy levels are throughout workouts" (participant 2,625)

Respondents commonly referred to energy-usage related to physical activity (e.g., 'energy-expenditure', 'calorie-output', 'kcals burned'), or total energy-expenditure (e.g., 'TDEE'), which is inclusive of energy used through physical activity and metabolic processes. Sensations relating to energy-usage were also reported, such as 'how tired/energized I feel after my work out routine' and 'exhaustion after […] workouts'. Similarly, respondents indicated paying attention to the subjective effort in performing an activity (e.g., 'perceived exertion', 'how comfortable I feel running various distances/speeds'). Physiological processes and related sensations that correspond to specific parts of the body were identified, including the heart (e.g., 'heart rate', 'pulse'), lungs (e.g., 'breathing', 'how winded I get […] bike riding'), blood (e.g., 'blood pressure') and sweat (e.g., 'how much I sweat'). Sensations were also indicated that concerned ingestion (e.g., 'hungry', 'signs of hydration (and dehydration)'), and one's musculoskeletal system (e.g., 'how sore I feel the day after', 'my body feels weaker and stiff', 'how strong my muscles are').

As shown in the quotation below, regarding the *Physique* subtheme, respondents indicated features that related to their physique as a whole (e.g., 'body', 'physical features'), and specific parts of the body (e.g., 'fat', 'muscles', 'arms', 'stomach'):

> "tracking daily, weekly, and bi-monthly weight and body fat percentage changes." (participant 2,865)

Greater detail was provided about their body by describing specific features, such as its composition (e.g., 'weight', 'muscle mass', 'body fat measurements'), and its size, shape and appearance (e.g., 'the size of my stomach', 'I lack tone', 'muscle circumference', 'skinny', 'physical appearance'). Respondents also paid attention to features relating to their body's ability (e.g., 'flexibility', 'have better form'), and how their clothes fit in relation their body (e.g., 'how tight or loose my work clothes feel').

The *Ingestion* subtheme, exemplified in the following quotation, comprised features relating to ingestive behaviour, and the substances that this necessitates:

> "Tracking my macros to ensure a 60% Carbs, 20% fats and 20% protein." (participant 1,976)

Different ingestive behaviours included ‘eating’, ‘food consumption’, ‘calorie-intake’ and ‘drinking’, while respondents also indicated abstinence from these behaviours (e.g., ‘fasting’, ‘fast periods’). Regarding ingested substances, respondents described the type (e.g., ‘meals’, ‘snacks’, ‘supplements’), amount (e.g., ‘how much I’m eating’, ‘grams’), energy-content (e.g., ‘calories-in’) and nutritional-content (e.g., ‘macronutrients’, ‘protein’, ‘carbs’).

The last Focus subtheme, *Physical and mental state*, comprised features relating to the respondents’ general physical and mental state (e.g., ‘health’, ‘wellness’, ‘fitness’, ‘ill’, ‘conditioning’), illustrated by the following quotation:

> “My overall feeling of physical wellness” (participant 132)

Features concerning specific mental states were also indicated, including mood (e.g., ‘happy’, ‘irritated’, ‘stressed out’), motivation (e.g., ‘how motivated I am’), concentration (e.g., ‘ability to focus’, ‘how clear my head feels’) and confidence (e.g., ‘my preparedness for upcoming sports season’, ‘competition ready’).

Self-monitoring

The theme *Self-monitoring* consisted of the techniques that respondents reported using to monitor their current state in relation to the varied features described within the *Focus* theme. These techniques were grouped into two subthemes: *Mental and sense-based monitoring*, and *Instrumental monitoring*.

The *Mental and sense-based monitoring* subtheme comprised self-monitoring techniques that do not necessitate anything other than a person’s mental processes and senses (although the enactment of these techniques might be supplemented with instruments). Self-monitoring terms comprising this subtheme included those within the sentence stem (i.e., ‘monitoring’, ‘keeping track’), as well as other general terms (e.g., ‘checking’, ‘assessing’). Explicitly mental and memory-based self-monitoring terms were also identified (e.g., ‘mentally keeping tabs on how much walking I’ve done’, ‘being aware of my activity levels’, ‘remembering what I’ve done’). This subtheme is succinctly exemplified in the following quotation:

> "[I monitor and keep track of my physical activity by…] Keeping track mentally. That's all." (participant 445)

Sense-based monitoring was often identified that related to specific *Focus* subthemes. For example, relating to the *Physique* subtheme, two types of sense-based monitoring were identified: visual monitoring (e.g., 'viewing physical features for change in definition', 'looking at myself'), and feeling (e.g., 'feeling my muscles'). Similarly, regarding the *Physiology* and *Physical and mental state* subthemes, respondents indicated interoceptive monitoring (e.g., 'listening to my body'). Last, mental approaches to quantification were also identified, such as counting (e.g., 'counting situps', 'I keep a mental tally of how much I'm lifting'), estimating (e.g., 'guesstimating', 'mentally approximating my calories'), misestimating (e.g., 'overestimating', 'underestimating', 'I log 2/3s of what the exercise equipment says I'm burning'), and calculating (e.g., 'calculating how many days a week I work out', 'thinking about it and doing arithmetic').

As illustrated in the following quotation, in contrast to the *Mental and sense-based monitoring* subtheme, the *Instrumental monitoring* subtheme comprised self-monitoring techniques that necessitated the use of instruments.

> "Using a wearable device to track heart rate, calorie burn and movement. Recording workouts in a mobile app." (participant 600)

Respondents reported using a variety of multipurpose instruments (e.g., 'using apps on my phone', 'wearable technology', 'websites'). Specific instruments and reasons for using these were also indicated. One example was timing (e.g., 'timing my bike rides'), which involved a variety of instruments (e.g., 'timers', 'looking at the clock', 'length of one tv episode'). Another instrumental monitoring technique was recording (e.g., 'logging the exercises I do', 'noting my runs'). A wide variety of instruments were used for the purpose of recording, including physical instruments (e.g., 'pen and paper', 'written log', 'whiteboard') and digital instruments (e.g., 'blogs', 'notes app', 'a photo of calories burned on exercise machines'). The passive use of digital instruments for monitoring and recording was also apparent (e.g., 'it automatically detects walking', 'automatically tracks physical activity', 'my phone

records my steps', 'a GPS unit that automatically uploads activities'). Various instruments were also reported that related to features within specific *Focus* subthemes. Specifically, several *Physical activity*-specific instruments were indicated (e.g., 'step counters', 'pedometer', 'treadmill machine readout', 'display page after I have used an exercising machine', 'power meter'). Other instruments were specific to the *Focus* subthemes *Physiology* (e.g., 'heart rate monitor', 'optical HRM'), *Physique* (e.g., 'scale to measure body fat and weight', 'weighing myself', 'taking various body measurements using a measuring tape') and *Ingestion* (e.g., 'weighing my food on a food scale'). Last, respondents commonly referred to specific brands of self-monitoring instruments (e.g., 'Fitbit', 'MyFitnessPal', 'Apple Health app', 'beyond the whiteboard').

Comparing

The theme *Comparing* related to the process of considering two or more states (typically the output of a self-monitoring technique, and a reference value), and determining the extent to which they are similar or different. Three subthemes were identified that related to different aspects of making comparisons: *Reference value*, *Comparative process* and *Evaluation of comparative outcome*.

The *Reference value* subtheme described the nature of features (i.e., *Focus* subthemes) against which another state (e.g., the output of self-monitoring) can be compared, as illustrated by the following quotations:

> "Doing a fitness test once a month, comparing how many of each exercise I can do month to month" (participant 1,303)

> "comparing workout scores to rest of the class (crossfit)" (participant 2,454)

Reference values commonly referred to specific points or periods of time in the past (e.g., 'last session', 'at the start of the year', 'when I felt skinny', 'when I had a different diet and fitness routine'), or previous achievements (e.g., 'personal bests', 'previous records'). Reference values concerning other people were also identified, including particular people (e.g., 'friends', 'other commuters', 'the rest of the class'), and more abstract references (e.g., 'what a normal person would do', 'benchmarks […] for my age and sex'). The last type of reference value corresponded to a target

(e.g., ‘goals’, ‘fixed amount of time’, ‘planned exercises’). Such targets were often framed in terms of a minimum (e.g., ‘a daily minimum of exercise’, ‘times to beat’, ‘at least twice a week’) or maximum (e.g., ‘exercise as often as I can’, ‘moving as much as possible’, ‘a calorie limit’).

Regarding the *Comparative process* subtheme, the process of comparing two states was both explicitly stated (e.g., ‘comparing’ states, one state ‘vs.’ another, seeing if one state ‘matches’ another), and implicit in the comparative outcomes (e.g., ‘more than’, ‘less than’, ‘skinnier’, ‘stronger’, ‘easier’). Several terms indicated a comparison to past states (e.g., ‘changes’, ‘journey’), and others also described the direction of such a temporal change (e.g., ‘increases’, ‘loss’, ‘progress’). Some comparisons involved states that all corresponded to the same feature within a *Focus* subtheme (e.g., ‘comparing reps at the gym to last week’s sessions’, ‘comparing stomach fat every few days’). In contrast, other comparisons involved one state compared to a state relating to a different *Focus* subtheme (e.g., ‘burn more calories than I eat’).

Last, the *Evaluation of comparative outcome* subtheme comprised subjective interpretations of the outcomes of comparisons (e.g., ‘how I feel about my progress’, ‘if I feel satisfied with […] results’, ‘how well I meet my goals’). Both positive and negative appraisals were identified (e.g., ‘losing weight means I have been successful in my physical activity’, ‘if I feel more tired doing the same routine I feel disappointed’).

6.4. Discussion

The aim of the current study was to provide a broad and comprehensive overview of the varied forms and focuses of physical activity self-monitoring. A diverse sample of 3,495 participants described how they monitor their physical activity, and, within their textual responses, three themes were identified: *Focus*, *Self-monitoring* and *Comparing*. Within the context of physical activity self-monitoring, the *Focus* theme highlighted features that were related directly to physical activity (e.g., duration,

type), as well as features related to other behaviours (e.g., energy-intake) and behavioural outcomes (e.g., physiology, physique). Both the *Self-monitoring* and *Comparing* themes indicated that control theory-related factors (Carver & Scheier, 1982) commonly feature in descriptions of physical activity self-monitoring.

Within the *Focus* theme, participants reported features that are not directly physical activity-related. Specifically, they described features regarding other energy balance-related behaviour (e.g., ingestion), and the outcomes of such behaviours (e.g., physiological processes and sensations, aspects of one's physique, perceptions of one's physical and mental state). This observation is consistent with theories of goal systems (Kruglanski et al., 2002), as one's physical activity can facilitate the achievement of various goals. For example, one might walk for longer to reach a target number of steps, although this might also facilitate the achievement of other goals (e.g., losing weight, lowering blood pressure, improving mood). Therefore, one's current physical activity-related state can be perceived by monitoring indirectly related behaviours or behavioural outcomes. However, evidence suggests that directly monitoring the focus that one wishes to maintain or change (e.g., physical activity) is more effective than indirectly monitoring the focus (e.g., perceiving physical activity levels through changes in one's physique; Harkin et al., 2016).

A clear distinction was made within the *Self-monitoring* theme between monitoring that only requires mental processes and/or senses (e.g., 'being aware', 'mentally keeping tabs'), and monitoring that necessitates the use of an instrument (e.g., physical logs, digital devices). This distinction was also observed for specific types of physical activity self-monitoring, such as recording (e.g., logging on paper vs. remembering) and quantifying (e.g., mentally counting sit-ups vs. using a digital step counter). This distinction raises important questions for the conceptualisation of self-monitoring, and the framing of research conclusions. For example, experimental investigations into self-monitoring often compare an explicit self-monitoring condition (e.g., completion of a diary) against a control condition without (e.g., Prestwich et al., 2016). However, if a goal is being pursued in both conditions, participants in the control condition might still self-monitor, but do so mentally rather than instrumentally. Consequently, instead of framing such manipulations as

the presence or absence of self-monitoring, it might be more accurate to frame these as manipulations of the form of self-monitoring (i.e., mental versus diary; cf. Dombrowski et al., 2016). This reframing could be important, as mentally self-monitoring might represent a person's preferred method. For example, they might lack trust in instruments and prefer to rely on their own memory. Therefore, for such a person, mentally self-monitoring (i.e., using their preferred method) might increase their adherence to behaviour change interventions (cf. Shay et al., 2009). The identification of self-monitoring by recording and quantifying aligns with research in support of these methods. Specifically, physically recording the information from self-monitoring (i.e., 'self-recording'; Korotitsch & Nelson-Gray, 1999), compared to not physically recording, has been found to lead to greater goal attainment (Harkin et al., 2016). Similarly, compared to non-quantified monitoring of one's goal progress, quantification is associated with a greater likelihood and perceived ease of monitoring (Chang et al., 2017).

The subthemes comprising the *Comparing* theme reflected aspects of control theory (Carver & Scheier, 1982) other than self-monitoring (e.g., reference values, comparative processes, evaluations of comparative outcomes). As participants were only asked to indicate the ways they self-monitor physical activity, their unprompted description of other control theory-related aspects suggests that the theoretical framework aligns with their own conceptualisation of self-monitoring. During the process of refining and naming the themes, the data captured by the *Reference value* subtheme mirrored and supported a previous distinction between three types of reference values (Harkin et al., 2016). Namely, that people hold reference values concerning a point or period in the past, a desired target, or other people.

The findings of the current study should be considered in the context of their limitations. First, on average, participants entered fewer than 20 words for their textual responses. While this was sufficient to achieve the aim of providing an overview of the forms and focuses of physical activity self-monitoring at a semantic level of analysis, more detailed responses would be required to explore the ways in which the different forms relate to each other. For example, while relative comparisons across different focuses were identified (e.g., 'burn more calories than

I eat'), the level of detail in the responses prevents further insight into how these different focuses are compared. Second, participants completed the sentence-completion task after self-report questions that related to the body, eating and physical activity. As such, it is possible that these self-report questions influenced participants' sentence-completion responses. Due to this potential bias, further analyses were not conducted into how frequently different self-monitoring methods and focuses were mentioned. However, this potential bias did not affect the current study's aim of producing a comprehensive (i.e., saturated) description of the forms and focuses of physical activity self-monitoring. Indeed, forms and focuses that were not assessed by the self-report questions were identified in participants' responses. Last, the sentence-completion task asked specifically about physical activity. As such, while other *Focus* subthemes (e.g., physique) were identified through the thematic analysis and should be considered of equal importance, it is possible that these subthemes were less saturated than the physical activity subtheme.

Through thematically analysing the textual responses of a large and diverse sample of participants, the current study provides a comprehensive description of the varied forms and focuses of physical activity self-monitoring. As such, the themes and examples presented above can be used to guide future research and intervention design. First, the findings bring attention to the variety of features that should be methodologically or statistically controlled in experimental studies and intervention trials. For example, participants indicated framing their physical activity in different ways (e.g., 'casual', 'deliberate', 'training'). As the framing of exercise has been found to influence subsequent behaviours (e.g., energy-intake; Fenzl, Bartsch, & Koenigstorfer, 2014), it is important that this framing is kept constant across experimental conditions. Second, this resource can be used to evaluate clearly the content validity of elements of a measurement tool (e.g., a self-report scale), such as how representative specific elements are of a construct (e.g., Haynes et al., 1995). Last, such reference lists of terms are increasingly important with the growing popularity of text-mining methods, such as that used in Study 2. Specifically, word-count methods rely on having comprehensive lists of terms relating to different constructs (e.g., Linguistic Inquiry and Word Count; Tausczik & Pennebaker, 2009).

While the previous text-mining study (Study 2) used terms relating solely to fitness trackers, the findings of the current study can facilitate a similar text-mining approach that relates to the broader physical activity self-monitoring construct. Indeed, the current findings are used in this way in the broader text-mining approach of Study 7.

6.5. Summary

In summary, the findings from the current study provide a comprehensive overview of the variety of forms and focuses of physical activity self-monitoring. With digital self-monitoring techniques (e.g., fitness trackers) receiving the majority of research attention in relation to eating psychopathology, it is important to investigate the wider variety of ways in which physical activity can be self-monitored. While the survey reported in this chapter provided a broad overview of the physical activity self-monitoring construct, it did not permit the researcher to probe participants for more detailed insights. As such, the following chapter details a series of semi-structured interviews to generate more detailed insights into the way in which physical activity is self-monitored by people with high levels of compulsive exercise, a population of particular theoretical interest.

7. Study 5:

Investigating the nature of physical activity self-monitoring in people with high levels of compulsive exercise

7.1. Introduction

Within the area of eating psychopathology and physical activity self-monitoring, research has predominantly focused on the use of fitness trackers, rather than considering other forms and focuses of physical activity self-monitoring. Addressing this issue, the online survey reported in the previous chapter aimed to outline the variety of forms and focuses by asking a large, diverse sample to complete the following sentence: "I monitor and keep track of my physical activity by…". In addition to the participants indicating the use of fitness trackers (e.g., *Fitbit*, *MyFitnessPal*), they also reported monitoring physical activity with other devices (e.g., exercise equipment) or without technology (e.g., listening to their body, remembering their exercise).

While the survey provided a comprehensive overview of the forms and focuses of physical activity self-monitoring, the depth of its insights was limited due to its methodology. Specifically, as the survey was conducted online to facilitate the recruitment of a large and diverse sample, and due to the respondents' anonymity, it was not possible for the researcher to ask for further detail about a participant's response. As such, in line with the survey's aim, the participants tended to report only the forms and focuses of their physical activity self-monitoring, with fewer insights into other aspects. For example, few patterns of engagement were identified, other than deliberately underestimating energy-expenditure, which was also identified in the analyses of comments on eating disorder forums that mentioned *MyFitnessPal* (Study 3).

As argued in a systematic review (Perski et al., 2016), engagement is an important factor to consider in relation to behaviour change techniques and, therefore, self-monitoring. Furthermore, as identified through the thematic analysis of social media comments about *MyFitnessPal* (Study 3) and other qualitative research into the use of fitness trackers (e.g., Eikey & Reddy, 2017; Honary et al., 2019), a consideration of psychosocial factors relating to physical activity self-monitoring (e.g., recovery-focus, behavioural consequences) is also important. However, as these previous studies

have focused on fitness trackers, the patterns of engagement and psychosocial factors they identified might be specific to these devices and apps. Alternatively, aspects specific to other forms of physical activity self-monitoring might not have been identified. In line with this thesis aiming to conceptualise the broader construct of physical activity self-monitoring, the study reported in this chapter aimed to investigate these aspects (i.e., engagement, psychosocial factors) in greater detail. To overcome the limitations of the online survey (Study 4), interviews were conducted for this study so that the participants could be asked to provide further detail about their responses.

Monitoring one's physical activity is suggested to be characteristic of people with high levels of compulsive exercise (Adkins & Keel, 2005). Relatedly, weight-control exercise, an aspect of compulsive exercise, has been indicated to be associated with the use of fitness trackers in a cross-sectional survey-based study (Plateau et al., 2018), and fitness trackers appear to be more commonly discussed in weight-management subreddits than in those focused on fitness and nutrition (Study 2). Consequently, due to the theoretical importance of compulsive exercise in relation to physical activity self-monitoring, participants indicating high levels of compulsive exercise were purposively recruited for the interviews reported in this chapter (cf. Bryman, 2016).

In summary, the aim of this study was to investigate the nature of physical activity self-monitoring in a sample of people with high levels of compulsive exercise. While the previous online survey (Study 4) focused on the forms and focuses of physical activity self-monitoring, the interviews specifically aimed to investigate the various ways in which the interviewees engaged in monitoring, and psychosocial factors associated with this.

7.2. Methods

7.2.1. Participants

Participants in this study were invited to participate in interviews based on the responses they provided in the previously reported online survey (Study 4). As such, participants in the interviews met the eligibility criteria for the survey: 18 years old or over, fluent in English, and not currently pregnant. Additionally, interviewees were required to: indicate a willingness at the end of the survey to participate in an interview, which was framed as investigating 'how people monitor and keep track of their physical activity'; be living in the United Kingdom at the time of interview; and consent to having their interview audio-recorded.

In total, 149 people fulfilled the inclusion criteria for the interview. The online survey responses were then used as a sampling frame (e.g., Bryman, 2016) to recruit participants based on their level of compulsive exercise. Specifically, all eligible respondents who equalled or exceeded a total score of 15 on the CET (Taranis et al., 2011) were invited to participate in an interview. This threshold (i.e., ≥15) was selected due to its use in detecting compulsive exercise in (female) clinical eating disorder patients (Meyer et al., 2016).

Overall, 38 people were invited to participate in an interview, and 13 completed one. Participants were not financially incentivised, and the study was granted ethical approval by the University of Warwick's Biomedical and Scientific Research Ethics Committee (REGO-2017-2112 AM01).

7.2.2. Procedure and interview protocol

All participants were interviewed individually by the author of this thesis. Participants were able to select to be interviewed in-person at the University of Warwick (*n*=3), or over the phone (*n*=10). All interviews were audio-recorded, and were conducted between April and August 2018. The washout period between participants completing an online survey and being interviewed ranged from 9 to 46 days (*M*=21, *SD*=11). Each interviewee provided informed consent online before participation, and verbally at the start and end of their interview.

The interviews were semi-structured, and followed a schedule that was developed in consultation with experts from exercise and eating disorder fields, and was piloted to facilitate comprehension. The interviewer started by introducing themselves, and explaining aspects of the study (e.g., audio-recording, right to withdraw, purpose of interview, intended uses of data, confidentiality and anonymity). In line with the aims of this study, the participants were then asked a range of questions to investigate the nature of their physical activity self-monitoring. The interviewees were asked questions about the following:

1) Their day-to-day physical activity in the domains outlined within the IPAQ (exercise and leisure, occupational, domestic, getting around; Craig et al., 2003). These questions aimed to help participants appreciate the breadth of their physical activity, and to assist the interviewer in prompting responses when asking subsequent questions.
2) The ways in which they monitored or kept track of their physical activity, and specific aspects of their monitoring (i.e., form, focus, engagement). These questions were asked due to the importance of the mode of, and pattern of engagement in self-monitoring (e.g., Perski et al., 2016).
3) Their satisfaction, and reference values regarding physical activity. Together with self-monitoring, reference values are a key aspect of control theory (Carver & Scheier, 1982). Additionally, within control theory, satisfaction can be viewed as when there is no discrepancy between one's current and ideal states (cf. Rothman, Sheeran, & Wood, 2009). Due to the importance of these factors to self-monitoring, the participants' responses to these questions were used to prompt further discussion about the forms and focuses of their physical activity self-monitoring, and the ways in which they engaged in it.
4) The cognitions and emotions that they experience before, during or after monitoring or tracking their physical activity. As with the previous questions, the interviewees were asked about cognitions and emotions to help prompt further discussion about the forms and focuses of their physical activity self-monitoring, and the ways in which they engage in it.

5) The reasons they felt they did or did not monitor or keep track of their physical activity. These questions were asked in case the interviewee did not consider themselves to monitor their physical activity, and had not mentioned a form of self-monitoring. For example, an interviewee might not have discussed mentally counting their exercise as a form of self-monitoring, even though it was of theoretical interest for this study.
6) Whether they wanted to add any further comments regarding the topics discussed in the interview.

7.2.3. Data analysis

As with Studies 3 and 4, the data collected in the interviews were thematically analysed. While this analysis followed the same six steps as the previous studies (i.e., generating and grouping codes, then defining and labelling themes; Braun & Clarke, 2006), an additional first step was to manually transcribe the audio-recording of each interview.

In a similar way to the previous studies, an inductive approach to thematic analysis was used to facilitate the identification of previously unconsidered themes in the data (e.g., Patton, 1990). Furthermore, a critical realist epistemological perspective was adopted. However, while the data collection in the previous two studies did not involve direct interaction between the researcher and participants, the semi-structured interviews enabled the researcher to ask additional questions to gather more detail regarding each response. Consequently, this methodology facilitated a better understanding of the context of participants' responses, and, as such, themes were considered at a latent level, rather than semantic themes that were explicitly represented in the textual data (cf. Studies 3 and 4).

As with the previous analyses, *NVivo* software (QSR International Pty Ltd., 2018) was used to facilitate the initial coding of the transcripts, and three other researchers ensured rigor in the analysis by acting as 'critical friends' (e.g., Smith & McGannon, 2017).

7.3. Results

7.3.1. Sample characteristics

The sample (*N*=13) comprised 9 female and 4 male participants, all of whom identified as the same gender as they were assigned at birth. The participants' ages ranged from 22 to 66 years (*M*= 30, *SD*=12), and their body-mass indices (calculated from self-reported height and weight) ranged from 15 to 27 kg/m^2 (*M*=22, *SD*=3). All participants were from the United Kingdom or Ireland except one, who was from The United States of America or Canada. Regarding ethnicity, 9 participants described themselves as 'White', while the remaining 4 all indicated different ethnicities ('Turkish', 'Asian', 'Arab', 'Asian and White'). The participants also indicated a range of employment statuses: employed full-time (*n*=5), self-employed (*n*=3), unemployed (*n*=2), and full-time student (*n*=3). From the first question the interviewer asked about physical activity to checking final consent, the interviews lasted between 20 and 61 minutes (*M*=31, *SD*=11).

The study inclusion criteria meant that all participants indicated a high level of compulsive exercise (i.e., at least 15 on the CET; Taranis et al., 2011), with their total CET scores ranging from 15.34 to 20.43 (*M*=17.20, *SD*=1.95). A summary of the sample's average scores on each CET subscale (Figure 9) shows that, on average, the sample scored relatively low on the Lack of Exercise Enjoyment subscale compared to the other subscales. Regarding their average (mean) weekly physical activity, as assessed by the International Physical Activity Questionnaire (Craig et al., 2003), the participants were vigorously active on 4 days (*SD*=2), were moderately active on 3 days (*SD*=3), and walked for at least 10 minutes at a time on 6 days (*SD*=1). Six participants also reported training and competing for a specific sport (3 at the time of interview, 3 previously), ranging from club to international level, and including swimming, tennis, badminton and running.

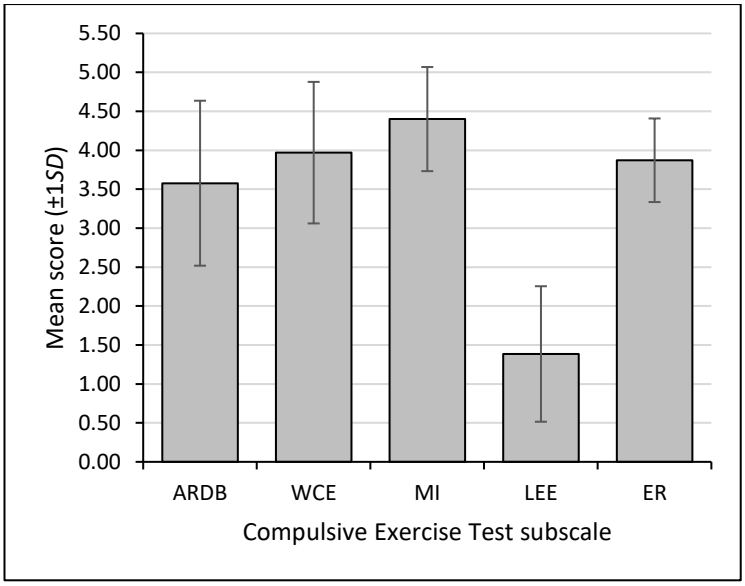

Figure 9. Average scores on Compulsive Exercise Test subscales. ARDB = Avoidance and rule-driven behaviour, WCE = Weight-control exercise, MI = Mood improvement, LEE = Lack of exercise enjoyment, ER = Exercise rigidity.

Five participants reported having previously received treatment for an eating disorder (anorexia nervosa, *n*=3; binge eating disorder, *n*=2). The participants' total scores on a measure of eating disorder symptomatology (EDE-Q; Fairburn, 2008) ranged from 1.10 to 4.89 (*M*=2.64, *SD*=1.20), with the sample mean exceeding a cut-off of 2.30 for the purpose of screening for eating disorders in the community (Mond et al., 2004).

7.3.2. Themes

The analysis resulted in the identification of four themes, which were labelled: *Engagement in monitoring*, *Assurance of physical activity*, *Physical activity comparisons* and *Monitoring other focuses*. All four themes are now described in turn, and are presented along with their respective subthemes and descriptions in Table 9. All subsequent terms in inverted commas are quotations made by the interviewees.

Table 9. Physical activity self-monitoring themes and subthemes

Theme	Subtheme	Description
Engagement in monitoring	Temporality of monitoring	Repetition of self-monitoring, and when it occurs relative to physical activity
	Intentionality of monitoring	Whether physical activity is self-monitored actively or passively
	Practicality of monitoring	Whether it is practical to engage in physical activity self-monitoring
Assurance of physical activity	Awareness of physical activity	Awareness of one's physical activity, and how this results from or influences physical activity self-monitoring
	Trust in monitoring	Extent to which knowledge arising from a form of physical activity self-monitoring is trusted and viewed as accurate
	Security from monitoring	Feel more secure and less anxious about physical activity when it is monitored
Physical activity comparisons	Physical activity reference values	Nature of reference values against which one's monitored physical activity is compared
	Effect of comparisons on cognitions and emotions	Effect of comparing physical activity on cognitions and emotions, such as satisfaction and guilt
	Effect of comparisons on physical activity	Effect of comparing physical activity on the behaviour itself
Monitoring other focuses	Non-physical activity behaviours	How monitoring other behaviours relates to physical activity
	Physique	How monitoring physique relates to physical activity
	Physiology and physical sensations	How monitoring physiology and physical sensations relate to physical activity

Engagement in monitoring

The theme *Engagement in monitoring* describes the ways in which physical activity self-monitoring was reported to be enacted. The theme comprises three subthemes:

Temporality of monitoring, *Intentionality of monitoring* and *Practicality of monitoring*.

The subtheme *Temporality of monitoring* describes when, relative to physical activity, the interviewees indicated self-monitoring, as well as their reported repetition of physical activity self-monitoring. Whether physical activity was a discrete bout (e.g., a run), or occurred at various points within a period of time (e.g., daily steps), self-monitoring was indicated to occur *during* the period of activity:

> "[…] I always run with music, and one thing I find quite useful is every one kilometre [the app] starts talking to you, and says, this is how far you've gone, this is how, the pace you're at at the moment." (participant 13)

> "[…] I'll check [the app] throughout the day and I can normally get 10,000 [steps] in before I get to work […]" (participant 4)

Interviewees also reported self-monitoring *after* being physically active, and indicated spending time reviewing their activity over various periods of time:

> "I check [the step counter] at bedtime. Only at bedtime. […] I look at bedtime, write it down. When I'm on holiday, and away from my computer, I take a little 3x5 index card and write down my steps at bedtime every night and put it in my computer when I come home." (participant 5)

> "Yeah, so every week, I'll sit down for maybe 20 minutes, 30 minutes and I'll look at all the different habits that I kind of input […] exercise is one of those things." (participant 6)

Interviewees reported monitoring with various degrees of consistency, from every time they are active ("I look at [the app] every day that I've been to the gym."), to sporadically ("I just check [the app] every so often."). The frequency of self-monitoring was also indicated ("I probably check [the app] at least, kind of, 20 times a day."). Last, interviewees reported that they felt their self-monitoring was habitual:

> "I guess it's kind of, like, I got into a kind of, like, a habit of mine to, sort of, like, just be aware of what I'm doing" (participant 3)

The interviewees also varied regarding the degree to which they intentionally monitored their physical activity, as outlined by the *Intentionality of monitoring* subtheme. While some interviewees reported that monitoring was deliberate ("[The *Fitbit*] doesn't then vibrate or anything, so it's me manually checking that."), others relied on technologies to provide feedback ("[…] those, like, little reminders and stuff are definitely how I interact with [the smartwatch]. So, I don't, I don't proactively check it.").

Last, as represented by the subtheme *Practicality of monitoring*, physical activity self-monitoring using technology was indicated to be both practical and impractical, which influenced engagement:

> "I can have like the, what's it called, my log book to be digitalised and such, so that things are a little bit more easy to see, easy to read, easier to monitor, easier than an Excel spreadsheet or anything." (participant 6)

> "I don't really keep track of my cycling or my tennis, 'cause, again, it's one of those things where I'd have to have some sort of phone on me at the time, and I don't tend to, for risk of falling out my pocket" (participant 13)

The findings within the *Engagement in monitoring* theme highlight that, in addition to the diverse forms and focuses outlined in Study 4, physical activity self-monitoring can vary greatly depending on how it is enacted. Specifically, the interviewees indicated monitoring their activity at different points in time (i.e., during or after physical activity), and referred to different patterns of repetition (i.e., consistently or frequently). Additionally, they reported monitoring either actively (i.e., deliberately monitoring) or passively (e.g., relying on reminders about their physical activity), and also depending on its practicality (e.g., if it was appropriate for the sport in which they were participating). Overall, this theme indicates that engagement in physical activity self-monitoring should be conceptualised as a multidimensional construct.

Assurance of physical activity

The theme *Assurance of physical activity* concerns the awareness the interviewees reported having of their physical activity, the trust they indicated having in information about their physical activity, and the feeling of safety they reported

getting from becoming aware of their physical activity. The theme comprises three subthemes: *Awareness of physical activity*, *Trust in monitoring*, and *Security from monitoring*.

Regarding the *Awareness of physical activity* subtheme, interviewees, unsurprisingly, indicated that monitoring their physical activity resulted in them being more aware of it, with some indicating that they stopped monitoring once they were aware:

> "[monitoring with the smartwatch has] definitely had, it's definitely made me more aware of how much activity I do in the day, 'cause I think before that, obviously, I had no idea" (participant 3)

> "[…] the first couple of times I [cycled to work] I did track it, with the same app I use for the running. But, other than that, I haven't really bothered, 'cause I sort of know how much it is." (participant 13)

Relatedly, some interviewees reported that when they were aware of their physical activity before doing it (e.g., an exercise session was planned or routine), they adopted a more approximate form of self-monitoring, or monitored less frequently:

> "I might look up how many laps it is or find out in advance what the route is, so I can just keep track and have some vague idea of where I am and what I'm doing." (participant 1)

> "[…] when I first got [the smartwatch] I was kind of checking it all the time to see like what different things would do, and if, you know, walking to [the shops] and back how much would that contribute. But, whereas now I've kind of, like, understood how much that, how much that's worth almost, and so, yeah, I don't need to check it as often" (participant 3)

The *Trust in monitoring* subtheme describes the trust interviewees expressed in different forms of physical activity self-monitoring. While some distrusted the accuracy of different forms of physical activity self-monitoring, others indicated that the form they used was sufficiently accurate:

> "This [step counter] is very inaccurate because it doesn't start counting steps until you've gone 10 steps, so it can be 1000 steps out for the day" (participant 5)

> "I don't trust, like, my brain recollection" (participant 6)

> "These apps are free, they're accurate to the extent that I need." (participant 10)

Additionally, in the case that a technology for self-monitoring physical activity is unreliable, interviewees indicated that an existing awareness of their physical activity mitigated negative emotions that might arise because of this:

> "I actually had a malfunction of my *Fitbit* a few days ago. It said that it had low battery and it didn't. And I didn't really panic about it, because, at the end of the day, I know how much I've walked." (participant 4)

Last, as represented in the *Security from monitoring* subtheme, interviewees indicated that the knowledge arising from monitoring their physical activity provides them with a sense of security, and that, if they cannot (or could not) monitor this, they feel anxious or upset:

> "You know how really young children have, like, a favourite toy they carry around? And they get really upset if they lose it? My app's a little bit like that. Well, my phone and my *Fitbit* is. So, if I lose that, I get really anxious. If I have it, I feel better. I just need to keep checking it." (participant 9)

> "[…] if you haven't been tracking, it's very easy to forget, oh well you know, I'm not fully recovered from the run I did two days before and the gym session, or you know my heartrate was a little high when I started, and then you can see that and it gives you more context. Whereas, without that tracking, it's just a crappy run, and you can feel a bit, sort of miserable about it, because you don't have full context of it." (participant 8)

More specifically, some interviewees indicated that, if they could not monitor their physical activity, they would become concerned about their weight and eating habits:

> "I'd feel really anxious. And I'd get scared of getting fat. And then it makes it harder for me to eat […] But I feel more guilty if I eat, or I feel that I can't eat, because what if I've done no exercise? […] Yeah, I'd feel a bit anxious. I just like checking [my phone]. I know it doesn't actually make any difference, I just like checking. If I can't check it, I feel like something bad is going to happen, like I'm going to get fat." (participant 9)

Reflecting the security gained from self-monitoring physical activity, interviewees also indicated that they would not feel they had been physically active unless they monitored it:

> "But now, I'm so used to having [the smartwatch] that it just almost would feel like, even though you did the run, that you didn't do the run because it hasn't recorded it." (participant 8)

The findings within the *Assurance of physical activity* theme suggest that the awareness of physical activity that is obtained through self-monitoring potentially provides a sense of security, and might, for example, prevent concern about one's weight and eating habits. Relatedly, if a form of self-monitoring is distrusted or malfunctions, an awareness of one's physical activity was suggested to minimise the experience of negative emotions. Overall, this theme indicates a potential relationship between the awareness of physical activity that results from self-monitoring, and whether one experiences a feeling of security or anxiety.

Physical activity comparisons

The self-monitoring of physical activity was implicit within discussion of comparisons, which are outlined in the *Physical activity comparisons* theme. The theme consists of three subthemes: *Physical activity reference values*, *Effect of comparisons on cognitions and emotions*, and *Effect of comparisons on physical activity*.

As the *Physical activity reference values* subtheme represents, the interviewees indicated comparing their physical activity to: other people ("[…] everybody goes to the whiteboard in the gym and writes up the time they did the workout in, so we can all compare […]"); their past ("[…] I'll look at information about how I've compared to other days."); and targets ("I try to aim for about 25 to 30 thousand steps, which

is about 13 miles, I think."). The choice of reference value was also reported to be dependent on sharing characteristics with the person (e.g., age, gender) or their current physical activity:

> "There have been some [other] women come through the gym, and they recorded their scores as well, and I can compare myself against them." (participant 1)

> "Occasionally, I look back to, it also tracks what the weather was at the time. So, sometimes you can think, well, okay, you know today was really cold, really wet or whatever, I'll compare it to the last one that was really wet, rather than the one in good conditions." (participant 13)

One interviewee indicated that comparisons to others led them to become competitive and enjoy their physical activity less ("I get overly competitive. And then I don't always, I don't enjoy it quite as much […]"). In line with this, to prevent themselves from becoming too competitive with others, or to conceal their physical activity from others, some interviewees reported either not sharing their data, or selecting a fitness tracker without the functionality to see others' data:

> "[…] I can't see anyone else's data […] 'cause if I'm seeing other people, I can compete with them." (participant 9)

> "So, I thought, if I just stop posting [my physical activity], 'cause people make comments as well, it's one of those things where it's like, I don't want to have to justify why I've got these, quite weird, I recognise it's a weird habit to walk 5 to 6 hours a day, I don't want to have to justify that to complete strangers." (participant 4)

Some comparative targets were framed in terms of how they were presented by technology ("when everything turns green", "complete the [visual] ring"), and they were also represented quantitatively ("get it up to, like, 20,000 [steps]").

Regarding the subtheme *Effect of comparisons on cognitions and emotions*, interviewees highlighted various cognitive and emotional outcomes from the comparison of their physical activity to a reference value. Positive comparisons (i.e.,

matching or exceeding the reference value) were stated to result in "a positive feeling", and feeling "relieved" , "pleased", or satisfied ("a weird satisfaction in seeing the numbers go up"). Furthermore, an interviewee indicated that a positive comparison "makes me, sort of, less guilty if I, like, wanna eat out or something".

Some interviewees reported that they are not particularly affected by negative comparisons ("Sometimes it's less than [10,000 steps], but I don't, it's fine, I don't get hung up on it."). In contrast, as a result of a negative comparison, others reported feeling "disappointed", "frustrated", "lazy" and guilty ("It makes me feel guilty if I haven't done as much as they have."), and, regarding other behaviours and outcomes, feeling "more guilty about, you know, just eating whatever", and "scared I'm going to get fat". Some also reported that a negative comparison results in greater motivation to review their data to gain a better understanding of their lower than expected performance:

> "My time has dropped drastically, I was getting 23 minutes, and now I'm on 29 minutes. And that's when I'm really looking into why am I slowing down? Whereas when I was getting faster scores, I wasn't thinking about it very much, I was just saying great, I've got faster, well done me." (participant 1)

The *Effect of comparisons on physical activity* subtheme highlights the effect that comparing physical activity has on the behaviour itself. In terms of motivation, comparisons of physical activity to a reference value were indicated to motivate being physically active ([…] "that motivation to complete that ring each day was, I don't know, I guess it keeps me going."). However, motivation was also reported in the absence of a reference value ("I'm not actually meeting a specific goal, but by logging it, I find it's motivating to, it encourages to keep it up.").

In line with an increase in motivation, if a comparison is negative, interviewees reported increasing their physical activity, or pushing themselves to match or exceed the reference value:

> "[…] if there's, like, a little bit left […] I'll just go for like a short walk in the evening or maybe like a quick run" (participant 3)

> "Obviously, if [the app is] saying I'm going a bit slowly, then I'll try and increase the pace a little bit." (participant 13)

Alternatively, some interviewees reported adjusting their target to compensate for the deficit resulting from a negative comparison (compared to a target of 10,000 steps, "if I've done 8,000 steps that day, before, I need to do 12,000 steps the next day."). One interviewee also indicated updating their target while exercising in line with quantitative feedback:

> "I'll check [the app] while I'm walking along, and then I'll sort of see where I'm up to. And it's like, it's going to sound really weird, but if I like that number, if I think that's a good number, cause I always have, I'll try and get to the next thousand, if it's over 500, if that makes sense?" (participant 4)

Concerns about doing too much exercise were indicated by several interviewees. Indeed, one interviewee stated that they did not use a fitness tracker because of exercising excessively ("I gave [my *Fitbit*] away because I was doing too much"), and later in the interview advised that "[…] if you have an eating disorder, I wouldn't recommend getting [a *Fitbit*]". Importantly, comparing their physical activity to others was indicated to help some interviewees identify their high level of physical activity:

> "[…] I do have, like, probably unhealthy behaviours regarding, I just realised that I probably do take it to extremes at times. It's a matter of keeping myself in check, as well. I think [comparing myself to my colleagues] has been quite good for that to see, sort of, what the average person does in comparison to me." (participant 4)

Last, while some interviewees indicated that comparisons to a target helped them to keep their physical activity lower, others reported that, while they might recognise their problematic habits, they might not act on the information:

> "Yeah, so I use [the app], I guess, so I don't exercise too much. Yeah, so I kind of use, it kind of helps me justify in my head that I've done enough exercise for the day." (participant 7)

> "Yeah, I mean, obviously, intellectually I know I should be, you know, taking an easy day, take a day off. In reality, do I actually take a day off? Yeah, maybe sometimes, but probably I'm not great about actually acting on that." (participant 8)

The findings within the *Physical activity comparisons* theme support the importance of considering physical activity self-monitoring in relation to the reference values to which an individual compares their physical activity (e.g., other people). As represented within this theme, the interviewees reported varying effects arising from a physical activity-related comparative outcome, such as feeling 'satisfied' having reached a target, or trying to increase their physical activity when they had not reached a target. Consequently, this theme emphasises the importance of considering physical activity self-monitoring in relation to physical activity reference values (i.e., as one aspect of physical activity comparisons).

Monitoring other focuses

Several interviewees indicated a general interest in self-monitoring ("[…] I like logging things. I like record keeping, it's fun."). The final theme, *Monitoring other focuses*, outlines the way in which monitoring non-physical activity related focuses relates to being physically active. The theme comprises three subthemes: *Non-physical activity behaviours*, *Physique*, and *Physiology and physical sensations*.

As represented by the *Non-physical activity behaviours* subtheme, the interviewees indicated self-monitoring behavioural focuses other than their physical activity. Most commonly, interviewees also reported monitoring their energy-intake:

> "I also have an app where I track everything that I eat. And just, yeah, I like to have the data so I can keep an eye on it." (participant 10)

Together with self-monitoring energy-expenditure, self-monitoring energy-intake enabled the identification of a calorie deficit, which subsequently influenced either or both behaviours:

> "[…] I probably couldn't cope if I wasn't doing any exercise, because I would just be afraid of gaining weight all the time. So, I think, while the exercise in

> itself can be a joyful thing, the tracking of it is directly linked to that for me. It's, where are my activity levels so I can calibrate what I'm eating?" (participant 10)

> "[…] if I went over on my [calorie-intake] every day, or something, I'd probably just sort of think, let's think, right, I need to make sure that I go to the gym every day […]" (participant 12)

In addition to physical activity, interviewees indicated self-monitoring their sleep behaviour, which was viewed as a way to evaluate their physical activity ("one of the things that happens with physical activity is that your sleep pattern is improved."). Self-monitoring the time spent working or doing hobbies ("musical practice", "language learning") was also indicated. One interviewee stated that the self-monitoring of studying aided the identification of over-exercising, and the subsequent revision of their goals:

> "[…] if I can't get to my, like, my five hours' of, like, complete concentration on a specific area [of study], then I feel bad because I'm exercising too much, and that's when I decided I need to get it down to 10,000 steps. It's because, I just decided, what's more important, getting a first [degree] or getting up to 30,000 steps?" (participant 9)

Interviewees reported self-monitoring physical activity due to an intention to maintain or change aspects of their physique ("My motivation for monitoring my physical activity, initially, was to maintain a healthy body weight, and to reduce my body fat […]"). With regards to the *Physique* subtheme, the interviewees discussed monitoring their physique to evaluate the effects of their physical activity ("[…] if I'm running more, then obviously the weight should go down."). Relatedly, when they were dissatisfied with an aspect of their current physique, they indicated that this influenced their thoughts about their physical activity:

> "I just find that when I'm walking around I might just do, so as a little check [of my fat], and that might tell me, like, that sort of triggers, like, how much have I worked out, has it been enough?" (participant 6)

In contrast, an interviewee indicated that due to feeling satisfied with their physique, they felt less need to monitor their physical activity:

> "[…] I have no need for [monitoring my physical activity], so why bother going through obsessively tracking all that when the evidence is writ large on my body […]"). (participant 2)

Regarding the *Physiology and physical sensations* subtheme, self-monitoring heartrate was reported as a means of better understanding and evaluating performance during a bout of physical activity:

> "[…] how my heartrate's affected during different stages of the exercises I'm doing." (participant 6)

> "I want to be running below a certain heartrate for this pace." (participant 8)

Energy-expenditure was also mentioned as aiding an understanding of the effect of physical activity ("estimated calories burned per mile"), although some interviewees did not monitor energy-expenditure due to perceived inaccuracies ("[my app is] inaccurate, it overestimates how many calories you've burned.").

In terms of physical sensations, these were reported to influence the performance of physical activity, or were perceived as outcomes of physical activity:

> "I just finish when I've finished all of [my exercises], really. Unless maybe on that day I feel like I could do a bit more, or I'm maybe a bit more tired than usual, so I'll cut one out." (participant 11)

> "You know, like, when you go to the gym and then the next day you ache. Like, I didn't really feel like it was doing this, and feel the effect of it, if that makes sense? And so I just dropped the things that I didn't really feel working, just sort of kept the things that did." (participant 12)

The final theme, *Monitoring other focuses*, demonstrates that physical activity self-monitoring potentially interacts with the self-monitoring of other focuses. Due to these other focuses typically relating to one's weight or energy-balance (i.e., energy-

intake and energy-expenditure), the findings suggest a potential relationship between physical activity self-monitoring and the management of one's weight.

7.4. Discussion

In this chapter, a series of interviews was reported that aimed to develop a better understanding of the nature of physical activity self-monitoring in 13 people indicating high levels of compulsive exercise. Overall, four themes were generated from the interviewees' responses. First, the theme *Engagement in monitoring*, which outlines the ways in which the interviewees engaged in physical activity self-monitoring. Second, aspects relating to the knowledge gained through physical activity self-monitoring are described in the theme *Assurance of physical activity*. Third, the theme *Physical activity comparisons* concerns the nature and effects of physical activity comparisons, in which self-monitoring is implicit. Last, the *Monitoring other focuses* theme details how monitoring focuses other than physical activity relates to being physically active.

Within the *Engagement in monitoring* theme, the importance of considering the breadth of this construct was further supported (cf. Perski et al., 2016). Existing research investigating fitness tracker use in relation to eating psychopathology has tended to focus on one aspect of engagement, the frequency of use (e.g., Plateau et al., 2018). Indeed, in line with these previous studies, the frequency of engagement in physical activity self-monitoring was supported in the current study as being an important aspect to consider in research (i.e., checking '20 times a day'). However, as previously discussed in reference to using *MyFitnessPal* when monitoring one's diet (Study 3), other aspects of engagement require assessment to ensure the identification of important relationships. In relation to self-monitoring diet with *MyFitnessPal*, consistency was argued to be a potentially important and overlooked aspect of engagement. As indicated by the current study, the consistency of engagement also appears to be an important consideration regarding the self-monitoring of physical activity. Taking the example of interviewees who reported checking their step counter once ("I check […] at bedtime. Only at bedtime."), this

pattern of engagement would represent a low frequency (i.e., once per day). However, the same interviewee reported reviewing this every day, including on holiday, suggesting that the consistency of engagement would be very high. Furthermore, variability in the consistency of self-monitoring physical activity was observed in the sample of the current study ("every day" to "every so often"), which might be explained by individual differences that were not controlled in the sampling (i.e., only a minimum level of compulsive exercise was specified). Consequently, future research should ensure to assess, at least, the consistency and frequency of engagement.

An additional finding described by the *Engagement in monitoring* theme was that engagement in physical activity self-monitoring appears to be influenced by its practicality. For example, a phone was reportedly not used to self-monitor cycling or tennis due to not having any way to safely carry it. Such a finding further exemplifies the problem with only considering one form of self-monitoring physical activity (i.e., fitness trackers) rather than a broader range of forms. Specifically, the impracticality of a form of self-monitoring could arguably lead to a person adopting a different, more practical form (e.g., logging exercise on paper after a bout). As the practicality of self-monitoring is potentially unrelated to psychological factors (e.g., eating psychopathology), it might therefore represent a confounding factor, which could conceal relationships between fitness tracker use and eating psychopathology. Whether assessing a broader range of forms of physical activity self-monitoring, or controlling for the practicality of using a fitness tracker, addressing this issue might enable a better understanding of patterns identified in previous research.

Regarding the *Assurance of physical activity* theme, the interviewees commonly indicated that self-monitoring physical activity increased their awareness of the behaviour. This finding was unsurprising given self-monitoring being synonymous with perceiving one's current state in control theory (Carver & Scheier, 1982). Furthermore, supporting the findings from the study concerning *MyFitnessPal* (Study 3), a distrust in technology was identified, although this was also found to extend to other forms of physical activity self-monitoring (i.e., distrust in the interviewees' own recollection). Of greater importance, the findings indicated that awareness of

physical activity influenced the self-monitoring of the behaviour. For example, when a bout of exercise was planned or routine (e.g., always running the same route), interviewees reported more approximate or less frequent self-monitoring. Such a finding is in line with the distinction made between reflective and automatic processes of behaviour change (e.g., Rothman et al., 2009). For example, self-monitoring is argued to be a technique by which a person consciously assesses their current state (e.g., physical activity), and is therefore viewed as a reflective process of regulating one's behaviour. In contrast, automatic processes regulate behaviour in line with associations developed through previous, repeated experiences (cf. habit; Verplanken & Orbell, 2003). Reflecting habit being proposed to play a central role in compulsivity (e.g., Gillan, Robbins, Sahakian, van den Heuvel, & van Wingen, 2016), the repetitive patterns of exercise characteristic of people with high levels of compulsive exercise (cf. Taranis et al., 2011) could be associated with automatic processes influencing physical activity more than reflective processes. In other words, if the physical activity of people with high levels of compulsive exercise tends to be more automatically regulated, it could be hypothesised that self-monitoring would be less frequent or consistent in this population than people with low levels of compulsive exercise. This hypothesis requires further testing, specifically, by examining the relationship between exercise rigidity and engagement in physical activity self-monitoring.

Another key finding within the *Assurance of physical activity* theme was that physical activity self-monitoring was seen as providing a sense of security. More specifically, the interviewees indicated that not monitoring physical activity would lead to negative cognitions and emotions (e.g., anxiety, guilt about eating, concern about becoming fat), and, therefore, self-monitoring physical activity was viewed as alleviating these experiences. Such a finding is in line with the purported overlap between eating disorders and anxiety disorders, and, more specifically, the use of safety-seeking behaviours (Pallister & Waller, 2008). Safety-seeking behaviours are considered characteristic of people with high levels of anxiety, and represent techniques that are ostensibly used to increase one's control in a situation and prevent negative outcomes (Salkovsis, 1991). However, these techniques are argued

to be counter-productive, and instead play a maintenance role in anxiety. Body checking has previously been framed as a safety-seeking behaviour (Pallister & Waller, 2008), as it is indicated to facilitate control over eating and body weight, and decrease anxiety (Mountford et al., 2006). Indeed, body checking can be defined as self-monitoring, which serves a self-regulatory function (cf. control theory; Carver & Scheier, 1982). Based on the findings of the current study, a possibility is that physical activity self-monitoring serves a similar safety-seeking role by facilitating the self-regulation of physical activity, and, therefore, alleviating specific anxieties, such as becoming fat. However, the use of physical activity self-monitoring in this way might be counter-productive, as it might distract from the source of one's anxiety (e.g., feelings about one's body), which could consequently maintain or reinforce the anxiety (e.g., Norton & Paulus, 2017). The potential use of physical activity self-monitoring as a safety-seeking behaviour therefore provides a strong rationale behind further investigation into the relationships between anxiety, eating psychopathology and physical activity self-monitoring. Indeed, in relation to eating psychopathology, such research is further justified as anxiety surrounding the use of fitness (and dietary) trackers was reported in the previous study concerning *MyFitnessPal* (Study 3), and other research (Eikey & Reddy, 2017).

The theme *Physical activity comparisons* captured the broader elements of control theory (Carver & Scheier, 1982), of which self-monitoring is one aspect. For example, in line with the conceptualisation of control theory as a discrepancy-reducing feedback loop, some interviewees indicated that a negative comparison led to further self-monitoring (i.e., reviewing data). Reflecting Harkin and colleagues' distinction (2016), the interviewees also reported comparing their physical activity to other people, the past, and ideal targets. Additionally, in line with social comparison theory (Festinger, 1954), interviewees indicated making comparisons to people with similar characteristics (e.g., gender), as well as previous physical activity performed under similar conditions (e.g., weather). Together with finding these three types of reference value in the large survey reported in the previous chapter, the distinction made by Harkin and colleagues is well supported. Consequently, when assessing comparisons, unless one type of reference value is of particular interest, all three

types of reference value should be considered. Regarding the previously discussed measure of body, eating and exercise comparisons (Fitzsimmons-Craft, Bardone-Cone, et al., 2012), only comparisons to others (e.g., peers, friends) were assessed. As such, in addition to not being able to make conclusions about the separate effects of self-monitoring techniques and reference values, findings arising from this measure cannot be uncritically applied to comparisons to other types of reference values (i.e., the past, ideal targets).

While cognitive and emotional consequences tended to be reported in line with the outcome of a comparison (e.g., feeling satisfied when a goal had been achieved), other interviewees reported not being affected in this way. Similarly, while some indicated that they were motivated to be more physically active in pursuit of a goal, others were reportedly motivated by self-monitoring alone (i.e., in the absence of a goal). Due to this variability in making comparisons of one's current state to a reference value (cf. control theory; Carver & Scheier, 1982), the findings suggest that physical activity self-monitoring does not always serve a self-regulatory purpose in this population, as self-monitoring might not always be performed in pursuit of a goal. As such, these findings further support the need to consider and assess self-monitoring techniques separately from making comparisons to reference values.

Last, as represented by the *Monitoring other focuses* theme, the interviewees reported monitoring focuses other than physical activity. While this theme was also observed in the previous survey (Study 4), the more in-depth analysis afforded by the current methodology enabled the identification of how monitoring these other focuses might relate to physical activity. Reflecting the content of the CET (Taranis et al., 2011) and the expert consensus on characteristics of compulsive exercise (Noetel et al., 2017), interviewees indicated monitoring their diet to compare it to their physical activity to calculate an energy deficit. Together with the self-monitoring of physique being commonly reported, these findings support weight-control exercise being an important aspect of compulsive exercise. The experts in Noetel and colleagues' study (2017) also reached a consensus that compulsive exercise interferes with other aspects of a person's life. Interestingly, an interviewee indicated that comparing the amount of time spent being physically active to that spent

studying helped to recognise how their exercise interfered with other aspects of their life.

In a similar way to monitoring one's physique, the result of self-monitoring physiology and physical sensations (e.g., heartrate, calorie-expenditure, tiredness) was indicated both to influence the performance of physical activity (e.g., reducing exercise due to feeling tired), and to evaluate the effect of physical activity (e.g., energy-expenditure during an exercise bout). In contrast to physique self-monitoring, the monitored aspects of physiology and physical sensations were specified in relation to specific aspects or bouts of physical activity (e.g., heartrate for a certain pace, calories burned per mile). Consequently, compared to monitoring one's physique, the results of self-monitoring physiology and physical sensations appear to be considered as more directly related to physical activity. Indeed, this finding is unsurprising given that changes in physiology and physical sensations are potentially more rapidly detectable than changes in one's physique.

One of the limitations of the study reported in this chapter concerns its sample size. In order to try and recruit a large sample, the survey detailed in the previous chapter was widely distributed and completed by a total of 3,698 participants. However, only 38 people fulfilled the eligibility criteria (e.g., a high level of compulsive exercise, currently living in the United Kingdom) and were invited to participate in an interview, and, of these, only 13 people participated. Further participants could have been recruited by lowering the threshold used to indicate a high level of compulsive exercise, or by interviewing participants outside the United Kingdom. However, these criteria were set due to the lack of an alternative threshold (cf. Meyer et al., 2016), and for practical reasons associated with conducting telephone interviews, respectively. While such issues with recruitment are common (Bernard, 2012), it is consequently difficult to assess the validity of the analysis, and the confidence that further interviews would not lead to the generation of additional codes or themes (i.e., data saturation; e.g., Guest, Bunce, & Johnson, 2006). More specifically, it is not possible to know whether the absence of a code or theme reported in previous research is due to the size, or the characteristics of the sample. For example, Eikey and Reddy (2017), and the previous study concerning *MyFitnessPal* (Study 3) found

that people with high levels of eating psychopathology reported deliberately underestimating their energy-expenditure. However, such a finding was not reported in the current study, which could be due to its sample size (or the choice of interview questions). An alternative explanation is that people with high levels of compulsive exercise do not tend to deliberately underestimate their energy-expenditure. As discussed above, physical activity self-monitoring might be more approximate or less frequent in people with more rigid patterns of exercise (e.g., running the same route each time), as such people might have a better knowledge of their physical activity. Consequently, as rigid patterns of exercise are characteristic of compulsive exercise, it could speculatively be that deliberate underestimation of exercise is of less benefit to this population, as they might have more accurate knowledge of their physical activity. While such speculation exemplifies the limitation of the current study, further research is needed to assess this.

Two further limitations relate to the conceptualisation and assessment of compulsive exercise. First, the threshold used to identify high levels of compulsive exercise was the same as used to detect compulsive exercise in female, clinical eating disorder patients (Meyer et al., 2016). As such, due to the inclusion of male participants in the sample, and no criteria being set relating to levels of eating psychopathology, a different threshold might have been more appropriate. However, due to the paucity of research into compulsive exercise (Touyz et al., 2017), the threshold used in this study was deemed the most appropriate. Second, compared to the other CET subscales (Taranis et al., 2011), the sample's average score on the Lack of Exercise Enjoyment subscale was relatively low (i.e., participants tended to enjoy exercise). As such, aspects of physical activity self-monitoring that are related to this factor might not have been identified in the current study. The relatively low score on the Lack of Exercise Enjoyment subscale could reflect a self-selection bias, as people who did not enjoy exercise might not have been motivated to participate in the interview (and initial survey). If such a self-selection bias is common across compulsive exercise research, less evidence might exist for this factor, which could potentially explain why a lack of exercise enjoyment was not an agreed characteristic of compulsive exercise in Noetel and colleagues' consultation with experts (2017).

Several clinical implications arise from the current findings for treating patients with compulsive exercise and eating disorders. As discussed, physical activity self-monitoring can be conceptualised as a safety-seeking behaviour. As such, if a patient's physical activity self-monitoring is controlled by clinicians (e.g., not permitting the use of fitness trackers), the patient might, at least initially, experience higher levels of anxiety, concern about their physique, and guilt related to eating. These potential emotional consequences should therefore be carefully considered by clinicians *before* addressing or controlling a patient's physical activity self-monitoring. Relatedly, if a patient's physical activity self-monitoring is controlled, but their exercise habits are not, targeting their self-monitoring might be ineffective due to the patient potentially possessing a good knowledge of their exercise without relying on self-monitoring. Restricting or changing a patient's physical activity without addressing their self-monitoring of it might also be ineffective, as the self-monitoring of a novel exercise routine might alleviate the experience of negative emotional consequences, which could hinder attempts to address the use of exercise for affect regulation (cf. Bratland-Sanda et al., 2011). Therefore, the current findings would suggest that it is important to address both a patient's physical activity, and their self-monitoring of it simultaneously. An important point to note is that some interviewees indicated that physical activity self-monitoring helped them to identify excessive exercise, and to address this. As such, it is possible that encouraging a patient to monitor their physical activity might be beneficial in some cases. However, caution should be taken in acting on this suggestion, as further research is needed to understand how to assess the role and influence of self-monitoring on an individual basis. A final implication of the current findings is that encouraging patients to monitor and compare other aspects of their life (e.g., leisure pursuits) to their physical activity might help them to become more aware of a negative impact of compulsive exercise on their quality of life. Indeed, as several interviewees indicated a general interest in self-monitoring, encouraging the self-monitoring of focuses unrelated to one's body or energy-balance might offer a useful substitute if attempting to reduce the self-monitoring of physical activity.

7.5. Summary

In summary, the current chapter reported a series of interviews that aimed to explore the nature of physical activity self-monitoring in people with high levels of compulsive exercise. As previous research in this area has tended to focus on one form of physical activity self-monitoring (i.e., the use of fitness trackers), the findings from the interviews helped to develop an understanding of the broader construct (i.e., other forms and focuses). While several subthemes and themes generated in the current analysis had been observed in previous research, additional findings resulted from these interviews. In addition to limitations arising from the current study's sample size, the identification of novel findings suggests that data saturation might not have been achieved by the existing research (e.g., Guest et al., 2006). As such, the final study in this thesis (chapter 9) is a further qualitative analysis using online forum comments, which aimed to assess the saturation of the themes relating to the broader physical activity self-monitoring construct (cf. focusing on *MyFitnessPal*; Study 3). However, to enhance the final study, the next chapter first reports a study that aimed to contribute to an understanding of the characteristics of the commenters on eating disorder subreddits.

8. Study 6:

Distinguishing commenters on online eating disorder forums with a high or low focus on recovery

The study presented in this chapter has been published in the *Journal of Medical Internet Research – Mental Health* (McCaig, Elliott, Siew, Walasek, & Meyer, 2019). Consequently, the content presented in this chapter is adapted from the published article.

8.1. Introduction

Throughout the studies presented in this thesis, and in line with the findings of other qualitative research (Eikey & Reddy, 2017; Honary et al., 2019), one's degree of recovery-focus is indicated to be a key consideration in terms of physical activity self-monitoring. Specifically, several qualitative studies found that people report reducing or ceasing their use of fitness trackers when attempting to recover from an eating disorder (Studies 3 and 5; Eikey & Reddy, 2017; Honary et al., 2019). In line with this, fitness trackers were also found to be more commonly mentioned in less recovery-focused eating disorder subreddits (Study 2). In contrast, with regard to compulsive exercise, some interviewees indicated that monitoring and comparing their exercise aided the identification and reduction of excessive levels of physical activity (Study 5).

Online eating disorder forums are typically distinguished in terms of their degree of recovery-focus, defined as either 'pro-eating disorder' (i.e., a low focus on recovery) or 'pro-recovery' (e.g., Branley & Covey, 2017). As such, the textual content from these forums can potentially offer insight separately into people who are or are not currently attempting to recover from an eating disorder. As previously reported, fitness trackers were more frequently mentioned in an ostensibly pro-eating disorder subreddit (*r/proED*) than in two pro-recovery subreddits (*r/EatingDisorders* and *r/fuckeatingdisorders*; Study 2). In line with this finding, in Study 3 the majority of comments mentioning *MyFitnessPal* were made on *r/proED* compared to the pro-recovery forums (1,644, compared to 15 and 36), although this could also be explained by *r/proED* being larger in absolute terms (i.e., comprising 387,357 comments, compared to 10,637 and 4,991).

While forums can be distinguished as either pro-eating disorder or pro-recovery, it is unlikely that individual commenters fall neatly within one of these categories. Indeed, regarding online eating disorder forums, it is possible that the same commenter engages with both pro-eating disorder and pro-recovery forums. Although, on average, the commenters in Study 2 tended to contribute to only one of the six subreddits, the contribution to multiple eating disorder subreddits might have been underestimated due to three of the subreddits relating to large, health-related subreddits. Consequently, a greater understanding of commenters' interaction with the different types of eating disorder subreddits could improve the qualitative insights generated from the *Reddit* data, by providing more context to the comments that the commenters make.

Previous studies have investigated different aspects of how users interact with eating disorder-related online content (e.g., Moessner et al., 2018; Tiggemann et al., 2018; Wang et al., 2018). For example, Moessner and colleagues used a network analytic approach with data from *Reddit* to investigate how commenters *within* the subreddit *r/proED* interacted with each other, and were able to identify particularly influential commenters. In contrast, Tiggemann, Wang and their respective colleagues compared the interaction *between* communities of commenters on *Twitter*. Specifically, Tiggemann and colleagues theoretically selected and compared content relating to thinspiration and 'fitspiration' (i.e., content encouraging health and fitness). During a two-week period, the researchers identified users that included thinspiration and/or fitspiration tags (i.e., keywords) in their posts, and found minimal overlap (i.e., interaction) between the commenters in the two communities. Using a more inductive (i.e., data-driven) approach to analyse data from *Twitter*, Wang and colleagues detected two communities of commenters who posted comments with eating disorder-related tags. The two communities were found to reflect the distinction between pro-eating disorder and pro-recovery content (cf. Branley & Covey, 2017), with network analyses indicating minimal overlap between the communities.

Building on these studies (Moessner et al., 2018; Tiggemann et al., 2018; Wang et al., 2018), the primary aim of the study reported in this chapter was to investigate the

overlap between eating disorder subreddits in terms of the users who comment on them. After calculating the commenter-overlap between the identified eating disorder subreddits, a mixed-methods approach (i.e., network analysis with community-detection, text-mining, manual review of the subreddits' topics) was also undertaken to categorise the identified eating disorder subreddits into subtypes based on their commenter-overlap, how they compare thematically, and their recovery-focus.

Following the identification of different subtypes of eating disorder subreddits, an additional exploratory analysis was conducted. Cross-sectional surveys have been used to gain a better understanding of the characteristics of the users of eating disorder forums (e.g., Aardoom et al., 2014; Harper et al., 2008; Peebles et al., 2012). However, when participants in these studies are recruited directly from the forums (e.g., Aardoom et al., 2014; Peebles et al., 2012), it is not possible to determine how representative the sample is of all the users of a specific forum, as the survey respondents might differ from users who did not respond. As such, analyses of online content that aim to elucidate characteristics of the commenters are an important way in which to address the limitations of cross-sectional surveys.

Reddit can be viewed as a microcosm of the internet, as it comprises hundreds of thousands of subreddits that relate to a vastly diverse range of topics. However, each *Reddit* user is likely to engage only with a relatively small number of subreddits that interest them. As such, together with the availability of *Reddit*'s data, the identification of the topics of subreddits to which a user (or group of users) contributes has the potential to gain an understanding of their (shared) characteristics (i.e., interests). This represents the aim of the additional exploratory analysis conducted as part of the current study. Specifically, for each subtype of eating disorder subreddit that was identified in pursuit of the primary aim, all the other (public) subreddits to which their commenters had contributed (i.e., 'ancillary subreddits') were identified. A mixed-methods approach similar to that used for the primary aim (i.e., network analysis with community-detection, manual review of the ancillary subreddits' topics) was then conducted, which enabled the profiling of the

commenters comprising each subtype of eating disorder subreddit in terms of the other topics in which they were interested.

8.2. Methods

8.2.1. Corpus selection and data analysis

Using the previously detailed archive of public *Reddit* comments (Complete Public Reddit Comments Corpus, 2018), while the archive includes all comments since December 2005, the study reported in this chapter used comments posted between March 2017 and February 2018 (inclusive). This represents the one-year period preceding the most recent month's data that were available when beginning the study. All data were extracted, pre-processed and analysed with *Python* programming language (Python Software Foundation, 2017), except where otherwise stated. The University of Warwick's Biomedical and Scientific Research Ethics Committee judged the study to be exempt from ethical review due to its use of publicly available data.

8.2.2. Categorising eating disorder subreddits

In pursuit of the primary aim, a list of search terms was created to identify eating disorder subreddits (Appendix F). This list was generated through consultation of eating disorder sections of two clinical references, DSM-V and ICD-10 (American Psychiatric Association, 2013; World Health Organization, 1992), and previous research concerning online eating disorder communities (e.g., Chancellor et al., 2016). Search terms were developed that related to: 1) eating disorders in general (e.g., eating disorder); 2) specific eating disorder diagnostic categories (e.g., anorexia nervosa, bulimia nervosa, binge eating disorder); or 3) online content associated with eating disorders (e.g., thinspiration). Subreddits were included that contained at least one search term in their name or brief description, but excluded if they: 1) were unrelated to eating disorders (e.g., *r/Anorexiclizardpeople*); or 2) were private. For each subreddit identified through this search and inclusion strategy, each comment and commenter name was then extracted from the *Reddit* data (Complete Public

Reddit Comments Corpus, 2018). In order to focus the analyses on the largest eating disorder subreddits, any subreddits with fewer than 500 commenters contributing within the one-year period were excluded. The *Reddit* commenters 'AutoModerator' and '[deleted]' were not included in this count, and were excluded from all subsequent analyses.

A mixed-methods approach was then used in order to identify subtypes of the eating disorder subreddits. This approach comprised three techniques, which are described below and were conducted in the order presented: 1) network analyses with community-detection; 2) text-mining; and 3) manual review of eating disorder subreddits' focuses.

Network analyses with community-detection

In order to conduct the network analyses with community-detection, a list of commenters was compiled separately for each of the included eating disorder subreddits. For each pairwise comparison of the subreddits (e.g., subreddit A compared to subreddit B), the proportion of each subreddit's commenters who had posted on the other subreddit was calculated, with the result ranging from 0 (no commenters overlap) to 1 (all commenters overlap). For example, 40/100 (0.4) of subreddit A's commenters might post on subreddit B, while 40/50 (0.8) of subreddit B's commenters post on subreddit A. The mean of these two proportions (i.e., 0.6) was calculated to account for differences in the number of commenters on each subreddit. A matrix was then created using all these pairwise comparisons, where each cell within the matrix represented the mean commenter-overlap between each pairing of the eating disorder subreddits.

Using this matrix, a weighted and undirected (i.e., associative) network analysis was conducted using the *qgraph* package (Epskamp et al., 2012) for *R* statistical software (R Core Team, 2015). Many techniques exist for the purpose of detecting communities (i.e., subreddits with similar commenters) within networks. The *walktrap* algorithm (Pons & Latapy, 2005) – with random walks of two steps – was used for this purpose, as it is recommended for networks with fewer than 1,000

nodes (i.e., subreddits; Yang, Algesheimer, & Tessone, 2016), and was observed to detect communities more reliably than other suitable algorithms.

As with individual subreddits, the detected communities might also overlap in terms of commenters (i.e., a commenter might contribute to subreddits from more than one community). As such, for each detected community, commenter lists were compiled and used to calculate the mean commenter-overlap between communities in the same way as detailed above for the pairwise comparisons of subreddits. In the event of more than two communities being detected, the *VennDiagram R* package (Chen & Boutros, 2011) was used to visualise these commenter-overlaps using unscaled Venn diagrams.

Text-mining

The text-mining approach used in Study 2 was used to establish the degree to which each eating disorder subreddit was recovery-focused (McCaig et al., 2018). For each eating disorder subreddit, the percentage of its comment-threads that contained at least one recovery term (i.e., 'recovery', 'recover', 'recovers', 'recovered', 'recovering') was calculated. A higher percentage of threads containing at least one reference to recovery was interpreted as representing a greater focus on recovery, in line with findings that recovery is less frequently mentioned by people who are not actively trying to recover from an eating disorder, or are in relapse (Keski-Rahkonen & Tozzi, 2005). For example, between May 2015 and January 2018 (inclusive), 10% of *r/proED*'s threads contained a reference to recovery, compared to 50% of *r/EatingDisorders*'s threads (Study 2). As this represented a 40% difference between the two, *r/EatingDisorders* was interpreted as having a greater recovery-focus than *r/proED*.

Manual review of eating disorder subreddits' focuses

A manual review of each eating disorder subreddit's name and brief description was undertaken to describe whether each subreddit related to: 1) eating disorders in general; 2) specific eating disorder diagnostic categories (e.g., anorexia nervosa, bulimia nervosa, binge eating disorder); or 3) online content associated with eating disorders (e.g., thinspiration). This step reflects the previously detailed distinctions

used in the generation of the initial search terms. The definitions were then considered together with the results from the previous two steps (i.e., network analysis with community-detection, and text-mining) to guide the categorisation of the eating disorder subreddits. For example, two subreddits specific to anorexia nervosa would have been categorised differently if they were present in two distinct communities representing different levels of recovery-focus. All authors stated on the published paper agreed on the categorisation of the eating disorder subreddits at this stage.

8.2.3. Profiling eating disorder-related commenters based on contributions to ancillary subreddits

For each of the subtypes of eating disorder subreddits identified through the previously described methods, a list was compiled of all the commenters who had contributed within the one-year period to at least one subreddit within the subtype (excluding 'AutoModerator' and '[deleted]' commenters). In order to focus this study on the largest subtypes of eating disorder subreddits, only subtypes with 1,000 or more commenters were included in the analyses. The following analyses were repeated separately for each included subtype of eating disorder subreddit.

Using the respective list of commenters for the eating disorder subreddit subtype, all of the other subreddits to which the commenters had contributed (i.e., ancillary subreddits) in the one-year period were identified. Any ancillary subreddits to which fewer than 1% of the subtype's commenters had contributed were excluded at this stage. This exclusion was made as ancillary subreddits with so few commenters would not have been included in the final steps of the analysis (detailed below), and therefore represented unnecessary data to extract.

The ancillary subreddits were then ranked separately in descending order of: 1) the number of the eating disorder subreddit subtype's commenters who had contributed to each ancillary subreddit; and 2) the proportion of each ancillary subreddit's total commenters (i.e., not only the subtype's commenters) that had also commented on at least one subreddit within the subtype. For each ancillary subreddit, the mean of these two ranks was then calculated. Due to the large number (i.e., tens of

thousands) of ancillary subreddits associated with each subtype, and to improve the interpretability of the results, the mean rank was used to identify the most representative ancillary subreddits for inclusion in the following analyses. Specifically, the 50 ancillary subreddits with the highest mean rank were included, resulting in the inclusion of ancillary subreddits that were both large in size (i.e., comprised many commenters), and included a large proportion of the subtype's commenters. This avoided the inclusion of ancillary subreddits that were very large in terms of the number of commenters, but of which the subtype's commenters comprised a very small proportion (e.g., general subreddits, such as *r/AskReddit*). At the same time, this step also avoided the inclusion of very small subreddits that had very high proportions of the subtype's commenters (e.g., subreddits comprising a few commenters who had all contributed to at least one subreddit within the subtype). As this threshold (i.e., the top 50 subreddits) was used solely to facilitate a clear interpretation of the results, extensions of this study could set different thresholds to explore the communities at varying levels of detail.

A mixed-methods approach was then used to profile the eating disorder subreddit subtype's commenters in terms of their main interests, as represented by the thematic focuses of the ancillary subreddits. This approach comprised two techniques, which are described below and were conducted in the order presented: 1) network analyses with community-detection; and 2) manual review of the ancillary subreddits' topics.

Network analyses with community-detection

The network and community-detection analyses were conducted in the same way as detailed previously. The only difference was that the commenter-overlaps (relating to both the ancillary subreddits and detected communities) were calculated using only the eating disorder subreddit subtype's commenters (i.e., excluding commenters on each ancillary subreddit who had not contributed to at least one of the subtype's subreddits).

Manual review of ancillary subreddits' topics

A manual review of each ancillary subreddit's name and brief description was undertaken to describe each subreddit's general topic. For example, the general topic of the subreddit *r/loseit* was described as 'weight-loss'. All ancillary subreddits comprising the detected communities were then reviewed, and a label was produced to represent the general content of each community. For example, a community containing ancillary subreddits that related to eating behaviours and weight-loss was labelled 'Eating/Body'. In order to ensure transparency at every stage of this process, the name and labels of all included ancillary subreddits are presented in tables in the next section, along with a summary of how each label for the detected communities was generated.

8.3. Results

8.3.1. Subtypes of eating disorder subreddits

The search and inclusion strategy led to the identification of 50 eating disorder subreddits (Appendix G). Following the exclusion of any subreddits with fewer than 500 commenters, nine eating disorder subreddits were identified: *r/BingeEatingDisorder*, *r/bulimia*, *r/EatingDisorders*, *r/eating_disorders*, *r/fuckeatingdisorders*, *r/MyProAna*, *r/proED*, *r/ProEDmemes*, and *r/thinspo*. In total, 14,024 commenters posted on these nine eating disorder subreddits. Of these commenters, 97 (0.7%) included the term 'bot' within their account name, with these commenters contributing a mean of 9 comments (*SD*=16, median=3, minimum=1, maximum=94) to the eating disorder subreddits. The network analysis with community-detection corresponding to the nine eating disorder subreddits is presented in Figure 10.

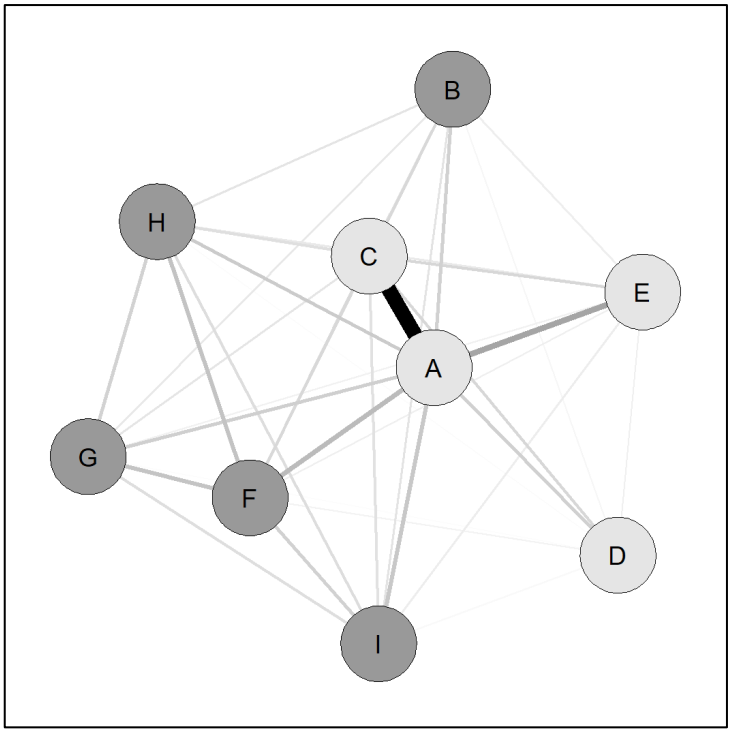

Figure 10. Eating disorder subreddits network. Letters correspond to eating disorder subreddits (A=r/proED, B=r/BingeEatingDisorder, C=r/ProEDmemes, D=r/thinspo, E=r/MyProAna, F=r/fuckeatingdisorders, G=r/EatingDisorders, H=r/eating_disorders, I=r/bulimia). Light-grey circles represent community 1 ("low recovery-focus"), dark-grey circles represent community 2 ("high recovery-focus"). Thickness of lines represents the mean degree of commenter-overlap between each pair of subreddits (thicker line = larger overlap).

Figure 10 shows that the community-detection algorithm identified two communities in the eating disorder subreddits network. The text-mining analyses found that community 1 (light-grey circles) comprised the four eating disorder subreddits with the lowest percentage of threads mentioning recovery: *r/MyProAna* (9.98%), *r/proED* (11.72%), *r/ProEDmemes* (2.38%), and *r/thinspo* (0.23%). In contrast, community 2 (dark-grey circles) comprised the five eating disorder subreddits with the highest percentage of threads mentioning recovery: *r/BingeEatingDisorder* (19.30%), *r/bulimia* (40.05%), *r/eating_disorders* (32.14%), *r/EatingDisorders* (46.38%), and *r/fuckeatingdisorders* (45.58%). These findings supported a conceptualisation of community 1 comprising 'low recovery-focus'

eating disorder subreddits, and community 2 comprising 'high recovery-focus' eating disorder subreddits.

Of the 14,024 commenters, 9,252 (65.97%) only posted on subreddits within the low recovery-focus community, while 4,023 (28.69%) only commented on subreddits within the high recovery-focus community. However, 749 commenters (5.34%) posted on subreddits within both communities, indicating relatively little commenter-overlap between the communities.

In addition to the degree of recovery-focus, the eating disorder subreddits also differed in terms of whether they concerned eating disorders in general (e.g., *r/EatingDisorders*), a specific eating disorder diagnostic category (e.g., *r/BingeEatingDisorder*), or online content associated with eating disorders (e.g., *r/thinspo*). Each subreddit's focus was therefore used to categorise the subreddits within each detected community. Consequently, the low recovery-focus community comprised three subtypes of eating disorder subreddits: 'pro-eating disorder', consisting of *r/proED* and *r/ProEDmemes* (8,166 commenters); 'thinspiration', consisting of *r/thinspo* (1,580 commenters); and 'pro-anorexia nervosa', consisting of *r/MyProAna* (731 commenters). As with the low recovery-focus community, the high recovery-focus community comprised three subtypes: 'pro-recovery eating disorder', consisting of *r/EatingDisorders*, *r/eating_disorders* and *r/fuckeatingdisorders* (1,986 commenters); 'pro-recovery binge eating disorder', consisting of *r/BingeEatingDisorder* (2,520 commenters); and 'pro-recovery bulimia nervosa', consisting of *r/bulimia* (524 commenters).

8.3.2. Commenters' contributions to ancillary subreddits

In order to focus this report on the largest subtypes of EDR-subreddits, subtypes with fewer than 1,000 commenters were excluded at this stage (i.e., *r/MyProAna* and *r/bulimia*). Consequently, the analyses regarding the second aim were conducted for four subtypes of eating disorder subreddits: two that are conceptualised as low recovery-focus (i.e., pro-eating disorder subreddits, thinspiration); and two that are conceptualised as high recovery-focus (i.e., pro-recovery eating disorder subreddits, pro-recovery binge eating disorder).

Low recovery-focus: Pro-eating disorder

In total, 974 ancillary subreddits had been contributed to by at least 1% of the 8,166 commenters associated with the 'pro-eating disorder' subtype (i.e., *r/proED* and *r/ProEDmemes*). 50 ancillary subreddits were identified on which 5,059 (61.95%) of the 8,166 pro-eating disorder subtype's commenters also posted. The network analysis with community-detection is presented in Figure 11, with a summary of the 50 ancillary subreddits presented in Table 10.

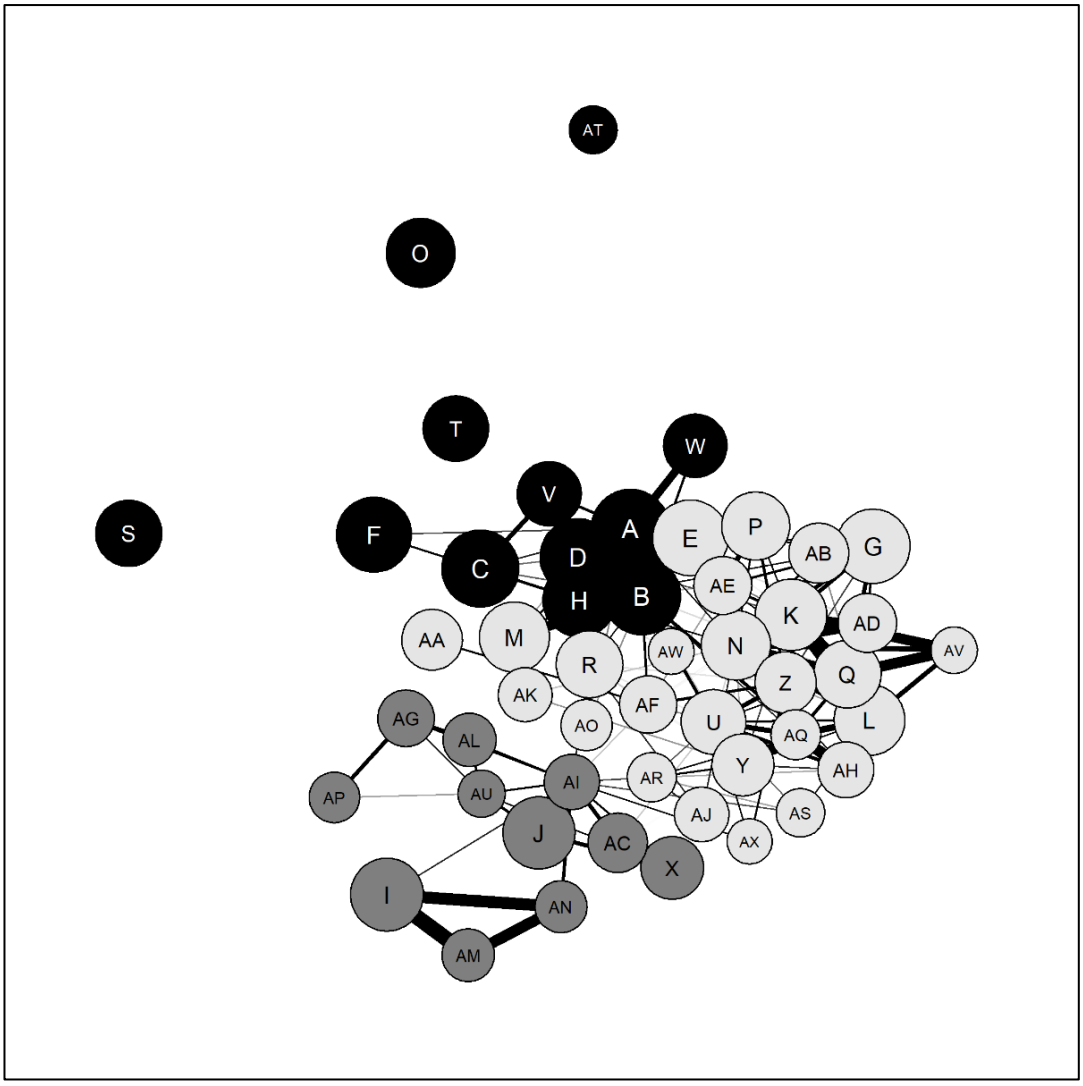

Figure 11. Pro-eating disorder network. Letters correspond to ancillary subreddits (Table 10 contains the names and descriptions of the subreddit to which each letter corresponds). Black circles represent community 1 ("Eating/Body"), dark-grey circles represent community 2 ("Mental health"), and light-grey circles represent community 3 ("Women/Appearance/Mixed"). Size of circles represents ancillary subreddit mean rank (larger circle = higher rank), and thickness of lines represents the mean degree of commenter-overlap between each pair of subreddits (thicker line = larger overlap). No lines representing <0.25 mean commenter-overlap are displayed.

Table 10. Names and descriptions of ancillary subreddits on which pro-eating disorder commenters posted

Community	*Rank*	*Label*	*Subreddit name*	*Description*
1	1	A	r/1200isplenty	1,200kcal daily energy-intake
1	2	B	r/fatlogic	Weight-loss
1	3	C	r/fasting	Fasting
1	4	D	r/progresspics	Photos of "body transformations"
1	6	F	r/BingeEatingDisorder	Binge eating disorder [19.08% threads mention recovery]
1	8	H	r/loseit	Weight-loss
1	15	O	r/EDFood	Food in the context of eating disorders
1	19	S	r/MyProAna	Anorexia nervosa [10.26% threads mention recovery]
1	20	T	r/thinspo	Thinspiration [0.24% threads mention recovery]
1	22	V	r/intermittentfasting	Fasting
1	23	W	r/1200isjerky	1,200kcal daily energy-intake
1	46	AT	r/proEDadults	Eating Disorders
2	9	I	r/selfharm	Self-harm
2	10	J	r/BPD	Borderline personality disorder
2	24	X	r/bipolar	Bipolar disorder
2	29	AC	r/morbidquestions	Ask "dark questions"
2	33	AG	r/depression	Depression
2	35	AI	r/SanctionedSuicide	Suicide
2	38	AL	r/Anxiety	Anxiety
2	39	AM	r/selfharmpics	Self-harm
2	40	AN	r/MadeOfStyrofoam	Self-harm
2	42	AP	r/SuicideWatch	Suicide
2	47	AU	r/mentalhealth	Mental health
3	5	E	r/xxfitness	Female fitness

3	7	G	r/femalefashionadvice	Advice on female fashion
3	11	K	r/MakeupAddiction	Make-up addiction
3	12	L	r/muacirclejerk	Make-up addiction
3	13	M	r/fatpeoplestories	Stories about "fat people"
3	14	N	r/SkincareAddiction	"Everything skincare"
3	16	P	r/TheGirlSurvivalGuide	"A survival guide of "life pro-tips" for the everyday girl"
3	17	Q	r/muacjdiscussion	Make-up addiction
3	18	R	r/vegan	Veganism
3	21	U	r/badwomensanatomy	Women's anatomy
3	25	Y	r/awfuleyebrows	Photos of eyebrows that are judged to be "embarrassing, ugly, and downright weird"
3	26	Z	r/TrollXChromosomes	Women
3	27	AA	r/raisedbynarcissists	"Support group for people raised by (or being raised by) a narcissistic parent"
3	28	AB	r/FancyFollicles	Hair
3	30	AD	r/AsianBeauty	Beauty brands, cosmetics and skincare from Asia
3	31	AE	r/AskWomen	Ask women about any subject
3	32	AF	r/childfree	People who do not have or want children
3	34	AH	r/antiMLM	Multi-level marketing schemes
3	36	AJ	r/piercing	Piercing
3	37	AK	r/amiugly	Commenter posts photo and asks for feedback on appearance
3	41	AO	r/vegetarian	Vegetarianism
3	43	AQ	r/Youniqueamua	Make-up addiction
3	44	AR	r/Shoplifting	Shoplifting
3	45	AS	r/thesims	Computer game (life simulation game)
3	48	AV	r/BeautyGuruChatter	Discuss beauty "influencers" and "YouTubers"
3	49	AW	r/bulletjournal	Method of organisation
3	50	AX	r/actuallesbians	Cis- or trans-lesbians

Note. Community 1 = “Eating/Body”; Community 2 = “Mental health”; Community 3 = “Women/Appearance/Mixed”.

As shown in Figure 11, the algorithm detected three communities within the pro-eating disorder network. Community 1 (black circles) was labelled "Eating/Body" as the ancillary subreddits related to restrictive eating (e.g., *r/1200isplenty*, *r/fasting*, *r/intermittentfasting*), weight-loss and/or body transformations (e.g., *r/loseit*, *r/fatlogic*, *r/progresspics*), and/or eating disorders (i.e., *r/BingeEatingDisorder*, *r/MyProAna*, *r/proEDadults*). Community 2 (dark-grey circles) was labelled "Mental health" as the subreddits mainly related to mental health conditions (e.g., *r/depression*, *r/Anxiety*, *r/bipolar*) and/or related issues (e.g., *r/selfharm*, *r/SanctionedSuicide*, *r/SuicideWatch*). Community 3 (light-grey circles) was labelled "Women/Appearance/Mixed" as the subreddits related to women (e.g., *r/xxfitness*, *r/TheGirlSurvivalGuide*, *r/AskWomen*), appearance (e.g., *r/MakeupAddiction*, *r/BeautyGuruChatter*, *r/amiugly*), and/or mixed topics (e.g., *r/vegan*, *r/childfree*, *r/raisedbynarcissists*).

Of the 5,059 pro-eating disorder commenters, 67.56% (*n*=3,418) also posted on ancillary subreddits within the Women/Appearance/Mixed community, compared to 61.24% (*n*=3,098) and 35.90% (*n*=1,816) in the Eating/Body and Mental health communities, respectively. Figure 12 presents the commenter overlaps between the three pro-eating disorder communities.

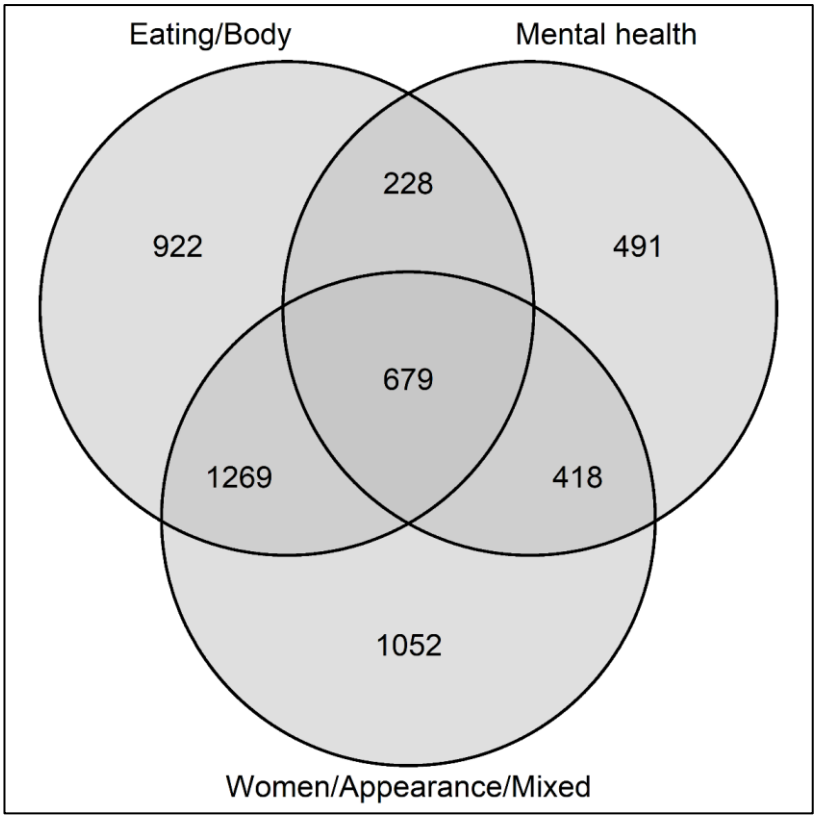

Figure 12. Commenter-overlap between pro-eating disorder communities. Values represent the number of commenters in the pro-eating disorder network (N=5,059) who posted in the three communities (represented by the three circles). Values in overlapping areas indicate the number of commenters who posted in two or more communities. Areas of circles are unscaled and do not represent size of communities.

Low recovery-focus: Thinspiration

In total, 3,932 ancillary subreddits had been contributed to by at least 1% of the 1,580 commenters associated with the 'thinspiration' subtype (i.e., *r/thinspo*). 50 ancillary subreddits were identified on which 1,086 (68.73%) of the 1,580 thinspiration subtype's commenters also posted. The network analysis with community-detection is presented in Figure 13, with a summary of the 50 ancillary subreddits presented in Table 11.

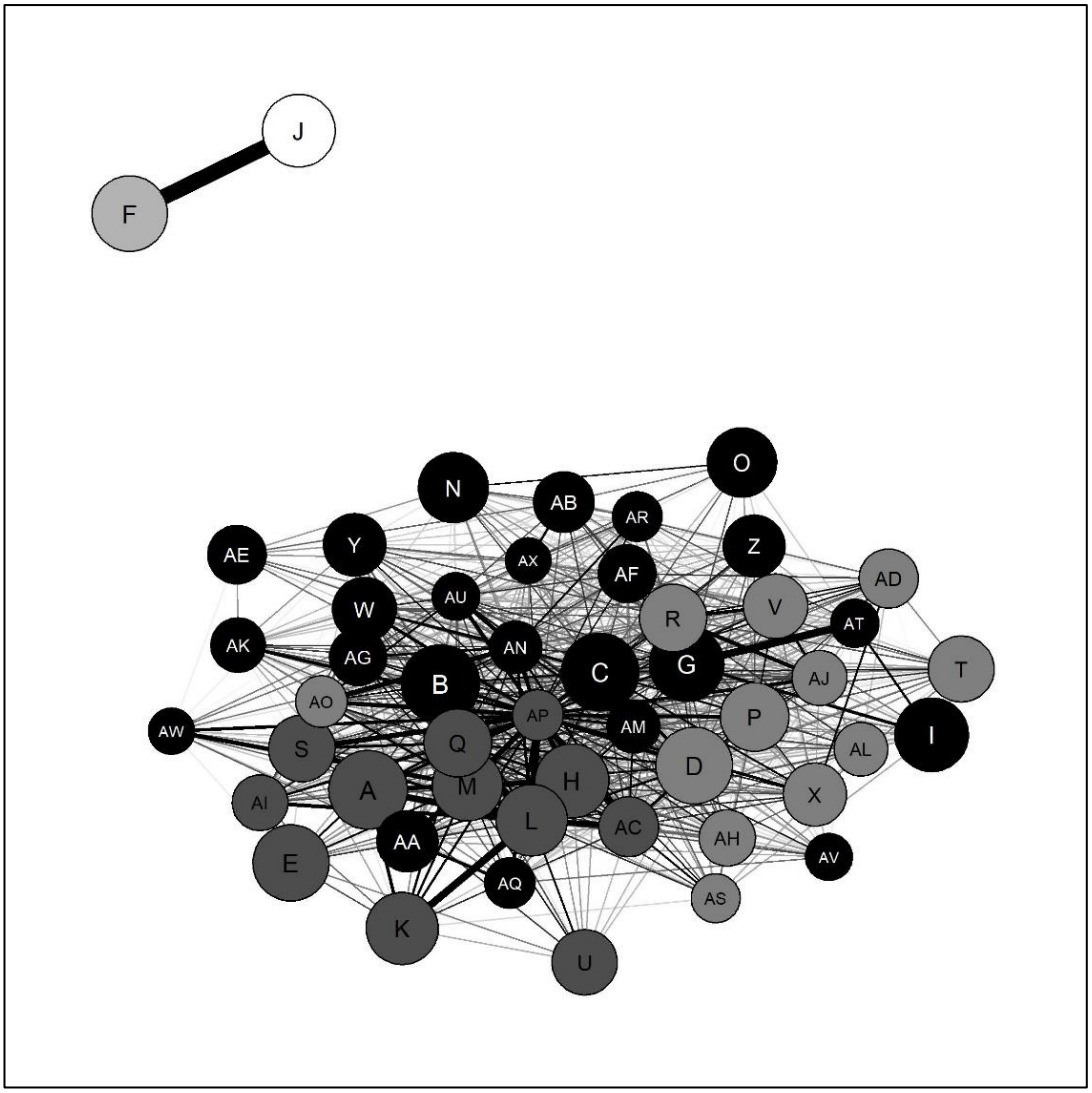

Figure 13. Thinspiration network. Letters correspond to ancillary subreddits (Table 11 contains the names and descriptions of the subreddit to which each letter corresponds). Black circles represent community 1 ("Pornography: 1"), dark-grey circles represent community 2 ("Pornography: young/small"), mid-grey circles represent community 3 ("Pornography: 2"), the light-grey circle represents community 4 ("r/ProEDmemes"), and the white circle represents community 5 ("r/proED"). Size of circles represents ancillary subreddit mean rank (larger circle = higher rank), and thickness of lines represents the mean degree of commenter-overlap between each pair of subreddits (thicker line = larger overlap). No lines representing <0.25 mean commenter-overlap are displayed.

Table 11. Names and descriptions of ancillary subreddits on which thinspiration commenters posted

Community	*Rank*	*Label*	*Subreddit name*	*Description*
1	2	B	r/CuteLittleButts	Pornography
1	3	C	r/SexyTummies	Pornography
1	7	G	r/fitgirls	Pornography
1	9	I	r/SkinnyWithAbs	Pornography
1	14	N	[omitted from report]*	Pornography
1	15	O	[omitted from report]*	Pornography
1	23	W	r/Ifyouhadtopickone	Pornography
1	25	Y	r/WtSSTaDaMiT	Pornography
1	26	Z	r/theratio	Pornography
1	27	AA	r/HugeDickTinyChick	Pornography
1	28	AB	r/goddesses	Pornography
1	31	AE	r/NSFWfashion	Pornography
1	32	AF	r/lingerie	Pornography
1	33	AG	r/FestivalSluts	Pornography
1	37	AK	r/uncommonposes	Pornography
1	39	AM	r/ginger	Pornography
1	40	AN	r/HappyEmbarrassedGirls	Pornography
1	43	AQ	r/distension	Pornography
1	44	AR	r/Ohlympics	Pornography
1	46	AT	r/hardbodies	Pornography
1	47	AU	r/girlskissing	Pornography
1	48	AV	r/GirlswithNeonHair	Pornography
1	49	AW	r/whenitgoesin	Pornography
1	50	AX	r/PrettyGirls	Pornography

2	1	A	r/xsmallgirls	Pornography
2	5	E	r/skinnytail	Pornography
2	8	H	r/funsized	Pornography
2	11	K	r/aa_cups	Pornography
2	12	L	r/TinyTits	Pornography
2	13	M	r/dirtysmall	Pornography
2	17	Q	r/LegalTeens	Pornography
2	19	S	r/18_19	Pornography
2	21	U	r/petite	Pornography
2	29	AC	r/palegirls	Pornography
2	35	AI	r/tanlines	Pornography
2	42	AP	r/adorableporn	Pornography
3	4	D	r/datgap	Pornography
3	16	P	r/bodyperfection	Pornography
3	18	R	r/tightdresses	Pornography
3	20	T	r/legs	Pornography
3	22	V	r/randomsexiness	Pornography
3	24	X	r/BonerMaterial	Pornography
3	30	AD	r/bikinis	Pornography
3	34	AH	r/nsfwoutfits	Pornography
3	36	AJ	r/girlsinyogapants	Pornography
3	38	AL	r/pokies	Pornography
3	41	AO	r/StraightGirlsPlaying	Pornography
3	45	AS	r/SexyFrex	Pornography
4	6	F	r/ProEDmemes	Eating disorders [2.42% threads mention recovery]
5	10	J	r/proED	Eating disorders [11.75% threads mention recovery]

Notes. Community 1 = “Pornography: 1”; Community 2 = “Pornography: young/small”; Community 3 = “Pornography: 2”; Community 4 = “ProEDmemes”; Community 5 = “proED”. The term ‘Pornography’ is used generally to describe any subreddit featuring material for the ostensibly exclusive purpose of sexual arousal.

*Name of subreddit relates to a specific person and is omitted from report.

As shown in Figure 13, the algorithm detected five communities within the thinspiration network. Community 1 (black circles) was labelled “Pornography: 1” as the ancillary subreddits were all pornographic in nature. Community 2 (dark-grey circles) was labelled “Pornography: young/small” as it mainly comprised pornographic subreddits that explicitly referred to women being young (e.g., *r/LegalTeens*, *r/18_19*) and/or small (e.g., *r/xsmallgirls*, *r/TinyTits, r/dirtysmall*). Community 3 (mid-grey circles) was labelled “Pornography: 2” as all the subreddits were pornographic. Community 4 (light-grey circle) was labelled “ProEDmemes” as it comprised only one subreddit, *r/ProEDmemes*. Similarly, community 5 (white circle) was labelled “proED”, as it consisted of *r/proED* only.

Of the 1,086 thinspiration commenters, 67.59% (*n*=734) also posted on ancillary subreddits within the Pornography: 1 community, compared to 59.85% (*n*=650), 46.13% (*n*=501), 20.99% (*n*=228), and 10.87% (*n*=118) in the Pornography: young/small, Pornography: 2, proED, and ProEDmemes communities, respectively. Figure 14 presents the commenter-overlaps between the five thinspiration communities.

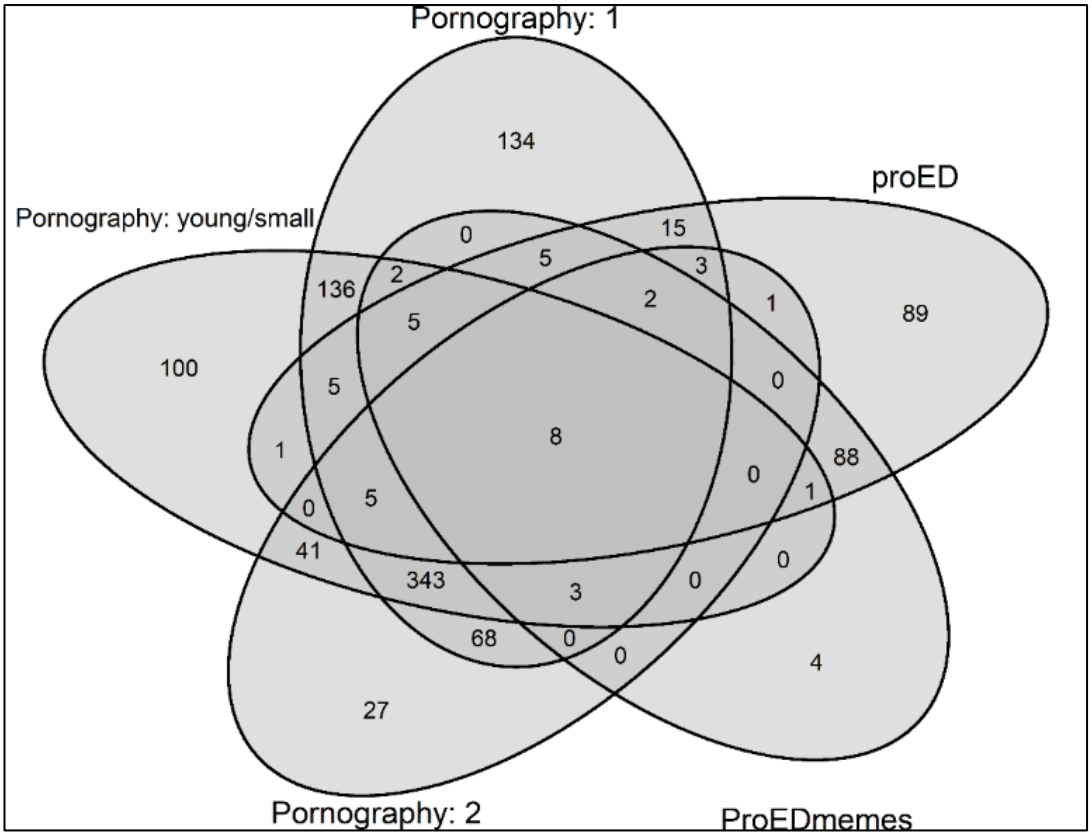

Figure 14. Commenter-overlap between thinspiration communities. Values represent the number of commenters in the thinspiration network (N=1,086) who posted in the five communities (represented by the five ovals). Values in overlapping areas indicate the number of commenters who posted in two or more communities. Areas of ovals are unscaled and do not represent size of communities.

As shown in Figure 13, a clear distinction was observed between the pornography communities (i.e., Pornography: 1, Pornography: 2, Pornography: young/small) and pro-eating disorder communities (i.e., ProEDmemes, proED). As such, the overlap between these two groups of communities was also calculated. Of the 1,086 commenters in the thinspiration commenter network, 849 (78.18%) only posted on ancillary subreddits within the pornography communities, while 181 (16.67%) only commented on subreddits within the pro-eating disorder communities. However, 56 commenters (5.16%) posted on subreddits within both groups of communities, indicating a small commenter-overlap between these groups.

High recovery-focus: Pro-recovery eating disorder

In total, 917 ancillary subreddits had been contributed to by at least 1% of the 1,986 commenters associated with the 'pro-recovery eating disorder subreddits' subtype (i.e., *r/EatingDisorders*, *r/eating_disorders* and *r/fuckeatingdisorders*). 50 ancillary subreddits were identified on which 1,414 (71.20%) of the 1,986 pro-recovery eating disorder subtype's commenters also posted. The network analysis with community detection is presented in Figure 15, with a summary of the 50 ancillary subreddits presented in Table 12.

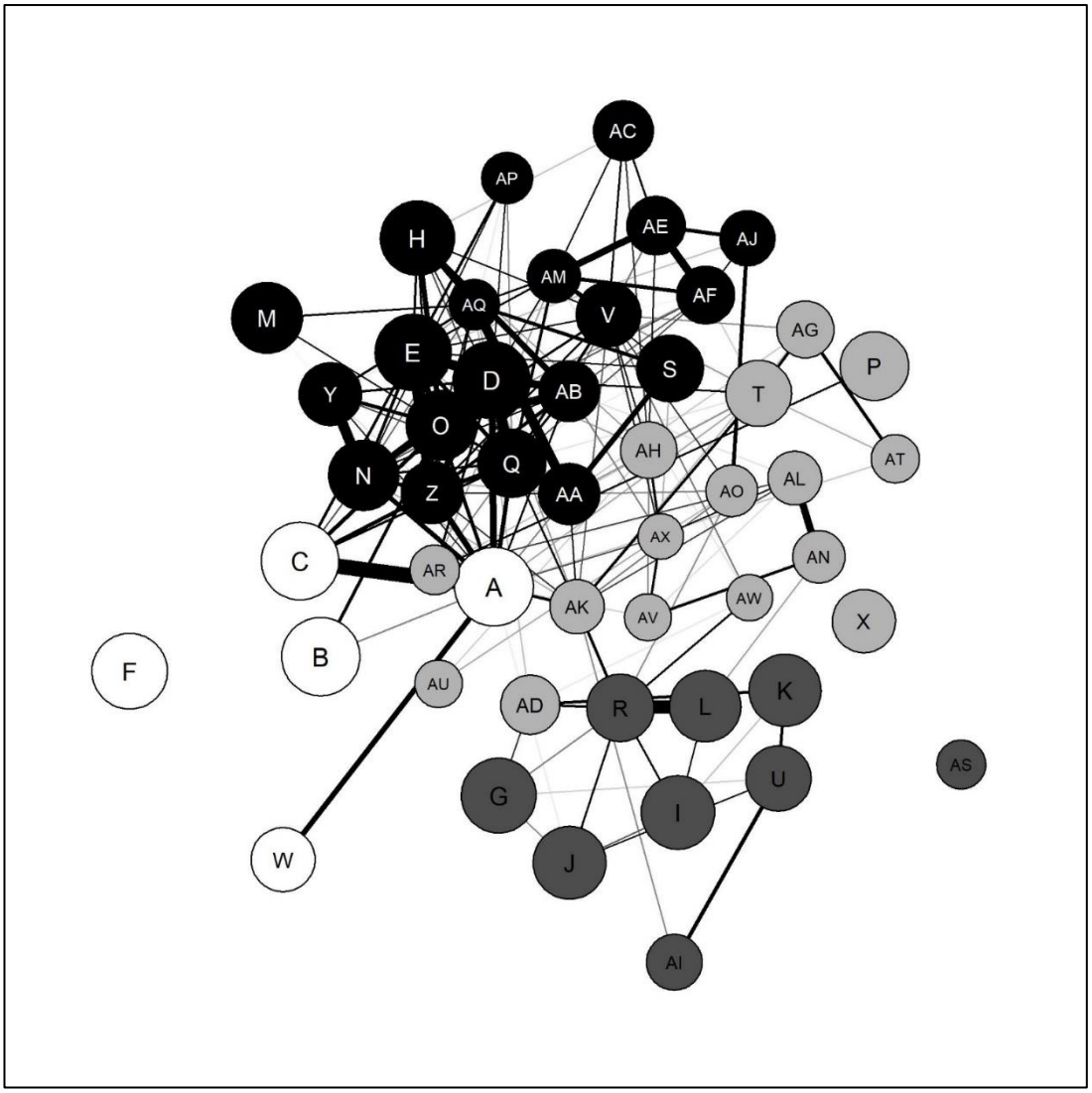

Figure 15. Pro-recovery eating disorder network. Letters correspond to ancillary subreddits (Table 12 contains the names and descriptions of the subreddit to which each letter corresponds). Black circles represent community 1 ("Eating/Body/Exercise/Appearance"), dark-grey circles represent community 2 ("Mental health"), light-grey circles represent community 3 ("Mixed"), and white circles represent community 4 ("Eating disorders"). Size of circles represents ancillary subreddit mean rank (larger circle = higher rank), and thickness of lines represents the mean degree of commenter-overlap between each pair of subreddits (thicker line = larger overlap). No lines representing <0.25 mean commenter-overlap are displayed.

Table 12. Names and descriptions of ancillary subreddits on which pro-recovery eating disorder commenters posted

Community	Rank	Label	Subreddit name	Description
1	4	D	r/fatlogic	Weight-loss
1	5	E	r/1200isplenty	1,200kcal daily energy-intake
1	8	H	r/xxfitness	Female fitness
1	13	M	r/nutrition	Nutrition
1	14	N	r/fasting	Fasting
1	15	O	r/loseit	Weight-loss
1	17	Q	r/fatpeoplestories	Stories about "fat people"
1	19	S	r/vegetarian	Vegetarianism
1	22	V	r/TheGirlSurvivalGuide	"A survival guide of "life pro-tips" for the everyday girl"
1	25	Y	r/intermittentfasting	Fasting
1	26	Z	r/1200isjerky	1,200kcal daily energy-intake
1	27	AA	r/vegan	Veganism
1	28	AB	r/progresspics	Photos of "body transformations"
1	29	AC	r/femalefashionadvice	Advice on female fashion
1	31	AE	r/MakeupAddiction	Make-up addiction
1	32	AF	r/muacirclejerk	Make-up addiction
1	36	AJ	r/FancyFollicles	Hair
1	39	AM	r/SkincareAddiction	"Everything skincare"
1	42	AP	r/EatCheapAndHealthy	"Eating healthy on a cheap budget"
1	43	AQ	r/veganfitness	“The place to come and discuss vegan fitness, bodybuilding, and health.”
2	7	G	r/mentalhealth	Mental health
2	9	I	r/BPD	Borderline personality disorder
2	10	J	r/selfharm	Self-harm
2	11	K	r/Anxiety	Anxiety

2	12	L	r/bipolar	Bipolar disorder
2	18	R	r/BipolarReddit	Bipolar disorder
2	21	U	r/depression	Depression
2	35	AI	r/SuicideWatch	Suicide
2	45	AS	r/offmychest	"Mutually supportive community where deeply emotional things […] can be told"
3	16	P	r/raisedbynarcissists	"Support group for people raised by (or being raised by) a narcissistic parent"
3	20	T	r/badwomensanatomy	Women's anatomy
3	24	X	r/ptsd	Post-traumatic stress disorder
3	30	AD	r/OCD	Obsessive compulsive disorder
3	33	AG	r/actuallesbians	Cis- or trans-lesbians
3	34	AH	r/AskWomen	Ask women about any subject
3	37	AK	r/SanctionedSuicide	Suicide
3	38	AL	r/TrueOffMyChest	Confessions
3	40	AN	r/confessions	Confessions
3	41	AO	r/piercing	Piercing
3	44	AR	r/childfree	People who do not have or want children
3	46	AT	r/bisexual	Bisexuality
3	47	AU	r/birthcontrol	“A place to discuss birth control methods.”
3	48	AV	r/AskDocs	Ask doctors about medical subjects
3	49	AW	r/ADHD	Attention deficit hyperactivity disorder
3	50	AX	r/askwomenadvice	“a subreddit dedicated to asking women for advice.”
4	1	A	r/proED	Eating disorders [11.75% threads mention recovery]
4	2	B	r/BingeEatingDisorder	Binge eating disorder [19.08% threads mention recovery]
4	3	C	r/ProEDmemes	Eating disorders [2.42% threads mention recovery]
4	6	F	r/bulimia	Bulimia nervosa [39.90% threads mention recovery]
4	23	W	r/MyProAna	Anorexia nervosa [10.26% threads mention recovery]

Note. Community 1 = “Eating/Body/Exercise/Appearance”; Community 2 = “Mental health”; Community 3 = “Mixed”; Community 4 = “Eating disorders”.

As shown in Figure 15, the algorithm detected four communities within the pro-recovery eating disorder subreddits network. Community 1 (black circles) was labelled "Eating/Body/Exercise/Appearance" as the ancillary subreddits mainly related to eating (e.g., *r/1200isplenty*, *r/nutrition*, *r/fasting, r/vegan*), weight-loss and body transformations (e.g., *r/loseit*, *r/progresspics*, *r/fatlogic*), exercise (e.g., *r/xxfitness*, *r/veganfitness*), and/or appearance (e.g., *r/MakeupAddiction*, *r/FancyFollicles*). Community 2 (dark-grey circles) was labelled "Mental health" as the subreddits related to mental health conditions (e.g., *r/Anxiety*, *r/bipolar*, *r/depression*), and/or related issues (e.g., *r/selfharm*, *r/SuicideWatch*). Community 3 (light-grey circles) was labelled "Mixed" as the subreddits related to a variety of topics (e.g., *r/AskWomen*, *r/OCD*, *r/piercing*). Community 4 (white circles) was labelled "Eating disorders" as the subreddits related to eating disorders in general (i.e., *r/proED*, *r/ProEDmemes*), and specific eating disorder diagnoses (i.e., *r/BingeEatingDisorder*, *r/bulimia*, *r/MyProAna*).

Of the 1,414 pro-recovery eating disorder commenters, 58.63% (*n*=829) also posted on ancillary subreddits within the Eating/Body/Exercise/Appearance community, compared to 50.28% (*n*=711), 46.18% (*n*=653) and 36.42% (*n*=515) in the Mixed, Mental health and Eating disorders communities, respectively. Figure 16 presents the commenter-overlaps between the four pro-recovery eating disorder communities.

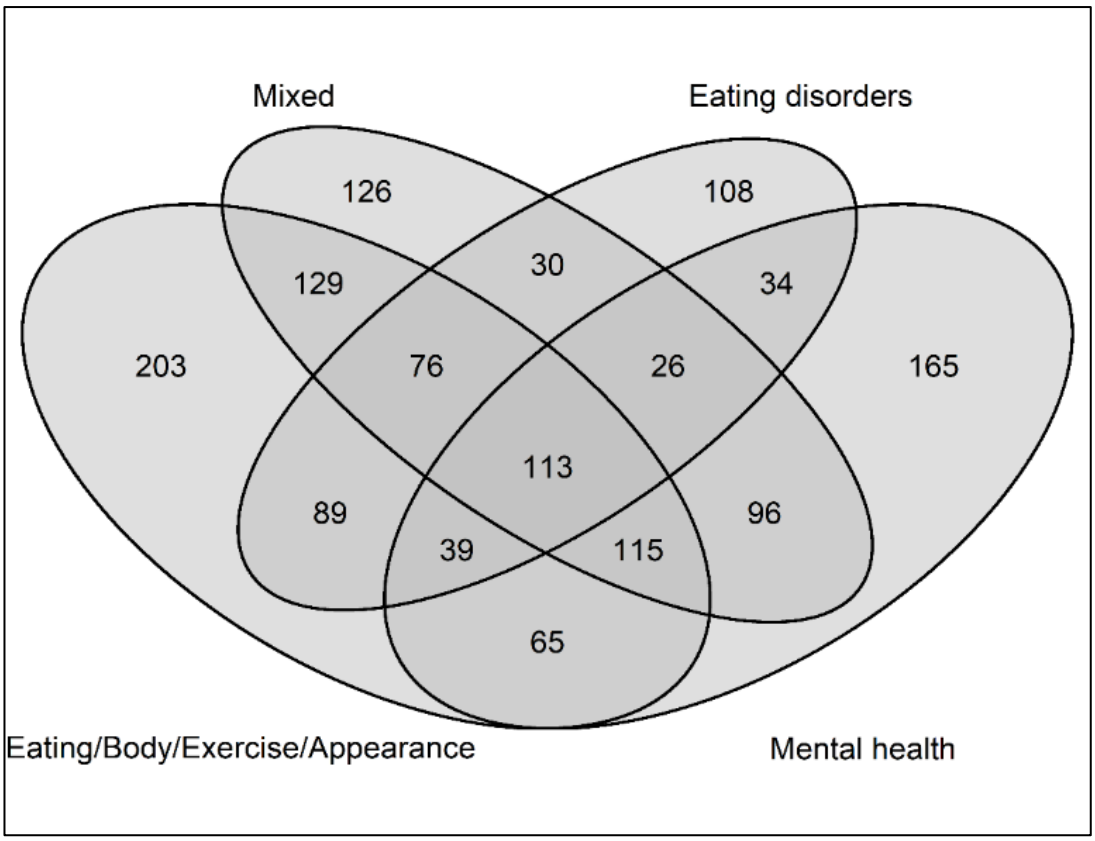

Figure 16. Commenter-overlap between pro-recovery eating disorder communities. Values represent the number of commenters in the pro-recovery eating disorder network (N=1,414) who posted in the four communities (represented by the four ovals). Values in overlapping areas indicate the number of commenters who posted in two or more communities. Areas of ovals are unscaled and do not represent size of communities.

High recovery-focus: Pro-recovery binge eating disorder

In total, 1,830 ancillary subreddits had been contributed to by at least 1% of the 2,520 commenters associated with the 'pro-recovery binge eating disorder' subtype (i.e., *BingeEatingDisorder*). 50 ancillary subreddits were identified on which 1,775 (70.44%) of the 2,520 pro-recovery binge eating disorder subtype's commenters also posted. The network analysis with community detection is presented in Figure 17, with a summary of the 50 ancillary subreddits presented in Table 13.

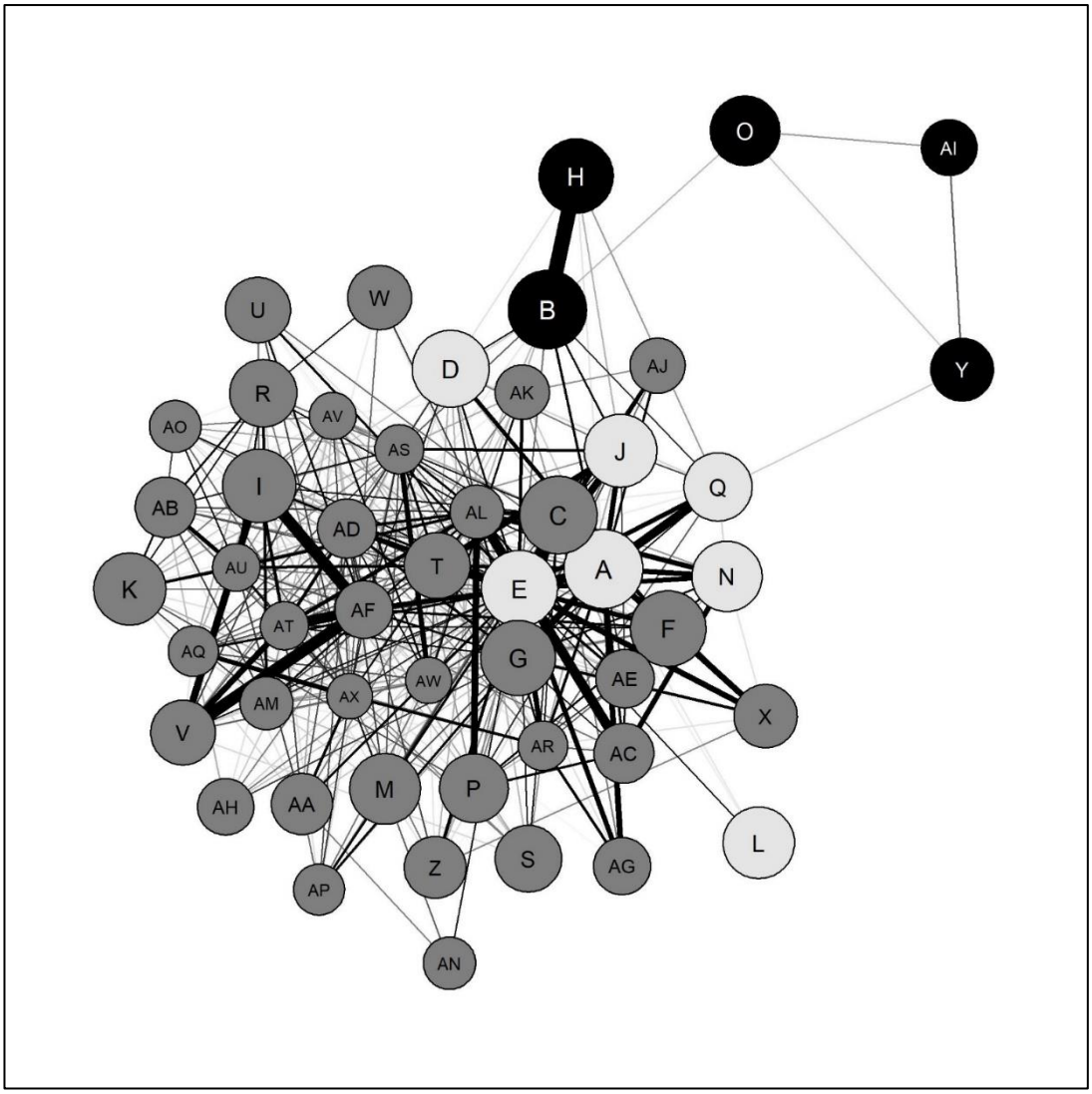

Figure 17. Pro-recovery binge eating disorder network. Letters correspond to ancillary subreddits (Table 13 contains the names and descriptions of the subreddit to which each letter corresponds). Black circles represent community 1 ("Eating disorders"), dark-grey circles represent community 2 ("Mixed"), and light-grey circles represent community 3 ("Eating/Body"). Size of circles represents ancillary subreddit mean rank (larger circle = higher rank), and thickness of lines represents the mean degree of commenter-overlap between each pair of subreddits (thicker line = larger overlap). No lines representing <0.25 mean commenter-overlap are displayed.

Table 13. Names and descriptions of ancillary subreddits on which pro-recovery binge eating disorder commenters posted

Community	*Rank*	*Label*	*Subreddit name*	*Description*
1	2	B	r/proED	Eating disorders [11.75% threads mention recovery]
1	8	H	r/ProEDmemes	Eating disorders [2.42% threads mention recovery]
1	15	O	r/fuckeatingdisorders	Eating disorders [46.59% threads mention recovery]
1	25	Y	r/eating_disorders	Eating disorders [32.78% threads mention recovery]
1	35	AI	r/EatingDisorders	Eating disorders [46.72% threads mention recovery]
2	3	C	r/xxfitness	Female fitness
2	6	F	r/intermittentfasting	Fasting
2	7	G	r/progresspics	Photos of "body transformations"
2	9	I	r/xxketo	Female keto diet
2	11	K	r/BPD	Borderline personality disorder
2	13	M	r/TheGirlSurvivalGuide	"A survival guide of "life pro-tips" for the everyday girl"
2	16	P	r/PlantBasedDiet	Plant based diet
2	18	R	r/mentalhealth	Mental health
2	19	S	r/Paleo	Paleo diet
2	20	T	r/fatpeoplestories	Stories about "fat people"
2	21	U	r/PCOS	Polycystic Ovarian Syndrome
2	22	V	r/ketorecipes	Keto recipes
2	23	W	r/Anxiety	Anxiety
2	24	X	r/1500isplenty	1,500kcal daily energy-intake
2	26	Z	r/EOOD	“Exercise Out Of Depression”
2	27	AA	r/getdisciplined	“A subreddit for people who have issues with procrastination, motivation, and discipline.”
2	28	AB	r/bipolar	Bipolar disorder
2	29	AC	r/veganrecipes	Vegan recipes

2	30	AD	r/C25K	Couch to 5k running programme
2	31	AE	r/vegetarian	Vegetarianism
2	32	AF	r/keto	Keto diet
2	33	AG	r/EatCheapAndHealthy	"Eating healthy on a cheap budget"
2	34	AH	r/Hair	Hair
2	36	AJ	r/femalefashionadvice	Advice on female fashion
2	37	AK	r/FancyFollicles	Hair
2	38	AL	r/veganfitness	“The place to come and discuss vegan fitness, bodybuilding, and health.”
2	39	AM	r/OCD	Obsessive compulsive disorder
2	40	AN	r/DecidingToBeBetter	“A force for self-improvement, goodness, and togetherness that helps humanity eliminate evil.”
2	41	AO	r/ADHD	Attention deficit hyperactivity disorder
2	42	AP	r/yoga	Yoga
2	43	AQ	r/curlyhair	Hair
2	44	AR	r/MealPrepSunday	Meal preparation
2	45	AS	r/muacirclejerk	Make-up addiction
2	46	AT	r/ketogains	“A community driven exploration into the pursuit of physical excellence via ketosis.”
2	47	AU	r/CPTSD	Complex post traumatic stress disorder
2	48	AV	r/bulletjournal	Method of organisation
2	49	AW	r/RedditLaqueristas	Nail polish
2	50	AX	r/internetparents	“Ask the internet about things your parents never taught you.”
3	1	A	r/1200isplenty	1,200kcal daily energy-intake
3	4	D	r/fasting	Fasting
3	5	E	r/loseit	Weight-loss
3	10	J	r/fatlogic	Weight-loss
3	12	L	r/nutrition	Nutrition
3	14	N	r/vegan1200isplenty	1,200kcal daily energy-intake (vegan)

3	17	Q	r/1200isjerky	1,200kcal daily energy-intake

Note. Community 1 = “Eating disorders”; Community 2 = “Mixed”; Community 3 = “Eating/Body”.

As shown in Figure 17, the algorithm detected three communities within the pro-recovery binge eating disorder network. Community 1 (black circles) was labelled "Eating disorders" as the ancillary subreddits related to eating disorders in general (e.g., *r/proED*, *r/EatingDisorders*). Community 2 (dark-grey circles) was labelled "Mixed" as it comprised a variety of subreddits (e.g., *r/xxfitness*, *r/mentalhealth*, *r/ketorecipes*). Community 3 (light-grey circles) was labelled "Eating/Body" as the subreddits mainly related to restrictive eating (e.g., *r/1200isplenty*, *r/fasting*), and/or weight-loss (e.g., *r/loseit*, *r/fatlogic*).

Of the 1,775 pro-recovery binge eating disorder commenters, 80.11% (*n*=1,422) also posted on ancillary subreddits within the Mixed community, compared to 64.56% (*n*=1,146) and 23.55% (*n*=418) in the Eating/Body and Eating disorders communities, respectively. Figure 18 presents the commenter-overlaps between the three pro-recovery binge eating disorder communities.

Figure 18. Commenter-overlap between pro-recovery binge eating disorder communities. Values represent the number of commenters in the pro-recovery binge eating disorder network (N=1,775) who posted in the three communities (represented by the three circles). Values in overlapping areas indicate the number of commenters who posted in two or three communities. Areas of circles are unscaled and do not represent size of communities.

8.4. Discussion

Using data from *Reddit* relating to 14,024 commenters, the study reported in this chapter primarily aimed to investigate the extent to which different eating disorder subreddits overlapped in terms of their commenters. Using a mixed-methods approach (i.e., network analysis with community-detection, text-mining, manual review of subreddits' topics), six different subtypes of eating disorder subreddit were identified, although two of these were excluded from the subsequent analyses due to comprising a relatively small number of commenters (<1,000). The remaining four subtypes could be distinguished based on their degree of recovery-focus (i.e., high or low). The low recovery-focus subreddits related to either eating disorders in general (pro-eating disorder), or a specific type of pro-eating disorder content (thinspiration).

Similarly, the high recovery-focus subreddits related to either eating disorders in general (pro-recovery eating disorder), or to recovery from binge eating disorder in particular (pro-recovery binge eating disorder). Using a similar approach to that addressing the primary aim, an additional exploratory analysis was conducted to elucidate the characteristics (i.e., shared interests) of the subtypes' commenters by identifying other forums to which they contributed (i.e., ancillary subreddits), and investigating the commenter-overlap between these subreddits.

Concerning the primary aim of this study, through the use of network analyses with community-detection, and a previously detailed text-mining technique (McCaig et al., 2018), two communities of eating disorder subreddits were identified that differed in terms of their degree of recovery-focus (i.e., low recovery-focus and high recovery-focus). The detection of these two communities, and the relatively small (5%) commenter-overlap between them, is in line with similar findings relating to pro-eating disorder and pro-recovery communities on *Twitter* (Wang et al., 2018). Furthermore, previous analyses of data from an online eating disorder forum indicated that commenters who are not actively trying to recover from an eating disorder, or who are in relapse, used recovery words less frequently than commenters who were actively trying to recover (Keski-Rahkonen & Tozzi, 2005). The current findings offer support for this, as recovery was indeed mentioned less frequently in ostensibly pro-eating disorder subreddits (i.e., *r/MyProAna*, *r/proED*, *r/ProEDmemes*, *r/thinspo*) than more recovery-focused subreddits (i.e., *r/BingeEatingDisorder*, *r/bulimia*, *r/eating_disorders*, *r/EatingDisorders*, *r/fuckeatingdisorders*). While the text-mining approach used textual data to assess the frequency of words' occurrence in comment threads, the network analyses with community-detection utilised behavioural data (i.e., data about the subreddits to which commenters contributed). As the results of the text-mining approach (i.e., degree of recovery-focus) align with the detected communities (i.e., the communities appear to differ on the basis of recovery-focus), a strength of this mixed-methods approach is that the two distinct techniques appear to provide a degree of convergent validity to each other.

Regarding the additional exploratory analysis, the topics in which commenters on pro-eating disorder subreddits were interested are in line with other research (Harper et al., 2008; Moessner et al., 2018; Sowles et al., 2018). Specifically, commenters on pro-eating disorder subreddits were also found, unsurprisingly, to be interested in the body, eating, mental health and appearance. As several identified subreddits were specific to women (e.g., *r/femalefashionadvice*, *r/TheGirlSurvivalGuide*), the results also support previous findings that suggest women are more likely to engage with pro-eating disorder-related online content (Branley & Covey, 2017; Ghaznavi & Taylor, 2015; Peebles et al., 2012).

In contrast to the pro-eating disorder results, the findings concerning thinspiration commenters were of great surprise. Namely, a clear majority of thinspiration commenters (78%) had also contributed to pornographic subreddits. Furthermore, a specific group of commenters contributed to pornographic subreddits that had names suggesting that women were young (including terms such as 'legal' or '18') and/or small (including terms such as 'tiny', 'petite' and 'small'). This finding is in line with previous research, which concluded that thinspiration images were typically sexually suggestive (Alberga, Withnell, & von Ranson, 2018; Ghaznavi & Taylor, 2015; Wick & Harriger, 2018). In fact, one study (Alberga et al., 2018) actually identified pornographic images in their search for thinspiration (and fitspiration) content, although these were excluded from the subsequent analyses. As indicated in the current study, the distinction between thinspiration and pornographic material is not clear. As such, it is important that researchers do not exclude specific material (e.g., pornographic images) from future analyses, as this might lead to a sanitised understanding of thinspiration content. The current study therefore highlights an issue of potentially great concern. Specifically, as thinspiration content typically comprises photos of extremely thin women (Ghaznavi & Taylor, 2015), the people submitting this content might not be fully aware of how their content is subsequently used. Speculatively, this lack of a complete understanding might lead to people unintentionally entering into vulnerable situations, and would therefore clearly warrant further research.

While the current findings might suggest that people engage with thinspiration for pornographic reasons, it is also possible that engagement with pornography and eating disorder symptomatology are related. For example, pornographic content might be viewed for the purpose of body comparison. However, only two studies appear to have explicitly investigated the relationship between pornography use and eating disorder symptomatology, both of which recruited exclusively male samples (Duggan & McCreary, 2004; Griffiths, Mitchison, Murray, & Mond, 2018). Given the apparent lack of research investigating this relationship in a female sample, and due to pro-eating disorder commenters typically being women (Peebles et al., 2012), this topic also represents an important avenue for future research.

Regarding the two high recovery-focus subtypes of eating disorder subreddits (i.e, pro-recovery eating disorder, pro-recovery binge eating disorder), the findings indicated similar subreddit communities as observed in the pro-eating disorder subreddit analyses. Specifically, the majority of commenters in both pro-recovery networks also commented on subreddits related to the body, eating, exercise and appearance. Subreddits related to mental health (e.g., *r/Anxiety*, *r/depression*) and relationships (e.g., *r/relationship_advice*, *r/relationships*) were also present in each network, supporting the importance of these issues to the commenters. In the case of the pro-recovery binge eating disorder subtype, the current findings support a qualitative analysis of binge eating disorder online content (Lord, Reiboldt, Gonitzke, Parker, & Peterson, 2018). Specifically, Lord and colleagues reported that content was commonly posted about the use of food to cope with negative feelings (e.g., emotional pain, fear) in the early stages of recovery from binge eating disorder. Furthermore, it was found that loneliness was a commonly mentioned negative feeling in this community, which may reflect the presence of relationship subreddits within the pro-recovery binge eating disorder analyses reported in this chapter.

Overall, a strength of the current findings is that they complement previous studies. While there are limitations (detailed below) to the current mixed-methods approach, its techniques can compensate for the methodological limitations of the previous studies. For example, survey-based studies concerning users of online forums are unlikely to have representative samples. As the current approach used data

concerning all the commenters on public forums, it is not subject to this limitation. As a result, by consolidating the findings generated from these distinct methodological approaches, greater confidence can be had that results do not simply represent an artefact of one particular technique (Munafo & Davey Smith, 2018).

These current findings must be considered in relation to the limitations of the data and methodology. First, it is important to note that the *Reddit* data are unsolicited. While this represents a strength of the data (e.g., the data are not liable to demand characteristics), this also results in a significant amount of noise in the data. Steps were taken to reduce this noise, such as only including 50 ancillary subreddits with a large number and proportion of eating disorder subreddit commenters in the network analyses. This approach identified the most representative subreddits by excluding very small subreddits (many of which had a high proportion but small number of commenters) and very large subreddits (many of which had a large number but low proportion of commenters).

Limitations arising from other sources of noise in the data are more difficult to mitigate. For example, the same person might have more than one *Reddit* username, for which there might be several reasons (e.g., separate personal and work accounts). With regard to eating disorder content, it is possible that a person has separate accounts for engaging with pro-eating disorder and pro-recovery forums, meaning that they could be a member of one forum without the members of the other knowing. This might be desirable for the user as, for example, a pro-recovery community might not welcome members who are also engaged with pro-eating disorder content. As these different usernames were assumed to be independent in the study reported in this chapter, it is therefore possible that the degree of commenter-overlap between the different types of eating disorder subreddits was underestimated. One way in which this could be addressed is by taking into account a user's IP address (i.e., an identifying number for their computer), although this would introduce ethical considerations, as this information is not publicly available. Additionally, 'bots' (i.e., automated software) exist that comment widely on subreddits, and which might contribute to an overestimation of commenter-overlap. While strategies exist to identify bots (Moessner et al., 2018; Stella, Ferrara, & De

Domenico, 2018), these might also exclude actual users. For this reason, bots (except 'AutoModerator', a generic *Reddit* bot) were not excluded, in order to adopt a conservative approach to the analyses. To minimise the effects of these sources of noise, the conclusions are based on communities of subreddits, rather than individual subreddits. While not necessarily a limitation of the present study, caution should be exercised in generalising these findings to other social media platforms (e.g., *Twitter*), and to people who have read, but not commented on, the online content. Exploring communities based on the content that users read would be important but ethically problematic, as this would likely require access to data that is not publicly available. Despite not being able to generalise to readers of forums, Aardoom and colleagues (2014) found that most survey respondents (87.2%) recruited from a pro-recovery eating disorder forum posted content, while the remainder only read content. Furthermore, algorithms exist that recommend subreddits in which users might be interested (Gerrard, 2018). Therefore, by focusing on commenters, users can be ensured to be actively engaged with the content, rather than being passively exposed to it. Similarly, private subreddits were not included in the present study for primarily ethical reasons. However, a private, eating disorder recovery-focused subreddit is advertised on a number of the public eating disorder subreddits. As such, the results regarding the high recovery-focus subreddits might differ were the private subreddit's commenters included. However, the private recovery-focused subreddit is less likely to influence the low recovery-focus analyses.

Regarding the approach used for the primary aim, the current findings have implications for how online communities related to eating disorders and, more generally, mental health should be conceptualised and investigated in future research. Specifically, when comparing multiple communities, the degree of user-overlap between these should be acknowledged. For example, Study 2 compared the frequency of fitness tracker mentions between three eating disorder subreddits (i.e., *r/proED*, *r/fuckeatingdisorders*, *r/EatingDisorders*). In the previous study, based on the frequency of recovery terms used in each subreddit, *r/proED* was framed as having a high-recovery focus, compared to *r/fuckeatingdisorders* and *r/EatingDisorders* having a low recovery-focus. While the findings of the current

study indicate that these subreddits do overlap in terms of their commenters, the results are consistent with the initial distinction (i.e., *r/proED* compared to *r/fuckeatingdisorders* and *r/EatingDisorders*), and therefore support the interpretation of the previous study.

Concerning the additional exploratory analysis, the findings have implications for future research, and the design of online psychological interventions for eating disorders and other mental health issues. Regarding future research, the approach presented here is entirely reproducible and can be used to explore similar questions in other groups of commenters of particular theoretical interest (e.g., relating to other mental health conditions). The methodology could also be easily extended to explore longitudinal – and, therefore, causal – patterns of commenting. The approach is also useful for hypothesis-generation and identifying new avenues of research. As detailed above, the current study generated a surprising finding, in that over three quarters of thinspiration commenters also commented on pornography. As this relationship had not been identified before, it is a clear indicator of how this approach can be used to identify areas that require greater research attention. Concerning implications for psychological interventions, the current approach can identify other topics that are of interest to people commenting on online mental health forums. For example, pro-eating disorder commenters were observed to be also interested in topics such as body, eating, mental health and appearance. Consequently, these topics confirm the importance of existing eating disorder intervention focuses (e.g., eating, and body shape and weight concerns; Fairburn et al., 2003). These findings could also be used to more accurately tailor interventions to the target population's characteristics (e.g., topics of interest), potentially increasing adherence to the programmes (Beatty & Binnion, 2016). Another implication for psychological interventions is that this approach can identify other forums in which there is a high activity of mental health forums' commenters. In the case of pro-eating disorder commenters, they were also observed to be active in subreddits including *r/1200isplenty*, *r/loseit*, and *r/progresspics*. As some mental health-related communities (e.g., pro-eating disorder) might be unlikely to promote psychological interventions, the current approach could be utilised to identify the

communities in which these users also tend to post. As a result, these communities could be approached to provide an alternative way in which to reach these people, and to target prevention-focused interventions.

A further implication concerns the finding that most thinspiration commenters also engaged with pornographic subreddits. A potential explanation for this finding is that people engage with thinspiration for pornographic reasons, which could put the people providing thinspiration content (e.g., sexually suggestive pictures of themselves; cf. Ghaznavi & Taylor, 2015) in vulnerable situations. As such, there is a need for social media platforms to prevent unintended, and potentially predatory, uses of the content that their users choose to contribute.

8.5. Summary

In summary, the findings from the current study provide further support for the distinction between eating disorder subreddits that have either a high or low degree of focus on recovery. Furthermore, the findings from the additional exploratory analysis contribute to the understanding of commenters on these forums, with the finding that thinspiration commenters also tend to contribute to pornographic subreddits being particularly concerning. Overall, the findings from this study can provide greater context to the comments on eating disorder subreddits, such as categorising whether the comments were made by a user who contributes to subreddits with either a low or high focus on recovery, or both. The final study in this thesis (chapter 9) aimed to use comments from eating disorder subreddits to evaluate the saturation of previously identified themes relating to the broader physical activity self-monitoring construct. As discussed at the beginning of this chapter, an individual's degree of focus on eating disorder recovery has been consistently indicated to be a particularly important factor to consider regarding physical activity self-monitoring. Consequently, the results of the current study are used to enable the saturation of themes to be considered in relation to the commenters' degree of recovery-focus, therefore enhancing the analysis of the final study.

9. Study 7:

Evaluating the comprehensiveness of the conceptualisation of physical activity self-monitoring in relation to eating psychopathology and compulsive exercise

9.1. Introduction

In line with the aims of this thesis, the preceding studies have attempted to inform the conceptualisation of physical activity self-monitoring in relation to eating psychopathology and compulsive exercise. The two studies that have most directly addressed this aim generated qualitative insights from comments on eating disorder subreddits that mentioned *MyFitnessPal* (Study 3), and interviews with 13 people with high levels of compulsive exercise (Study 5). Together with qualitative insights from other research (Eikey & Reddy, 2017; Eikey et al., 2017; Honary et al., 2019), the varied sources of data used in these studies enable the triangulation of the findings (cf. Erzberger & Prein, 1997). Indeed, several insights can be observed in more than one of these studies, such as the deliberate underreporting of levels of physical activity being observed in the analysis of online comments mentioning *MyFitnessPal* (Study 3), and in the interviews conducted by Eikey and Reddy (2017).

Although physical activity self-monitoring can take a variety of forms (cf. Study 4), fitness trackers have tended to be the sole focus of research in relation to eating psychopathology (cf. Eikey & Reddy, 2017; Eikey et al., 2017; Honary et al., 2019). While the analysis in Study 3 similarly focused only on the use of *MyFitnessPal*, the interviews (Study 5) addressed this issue by investigating physical activity self-monitoring more broadly. However, the small number of interviews coupled with the identification of novel findings raised concerns that data saturation might not have been achieved (i.e., further interviews could have potentially generated additional themes; cf. Guest et al., 2006). As such, the study reported in this chapter aimed to evaluate the comprehensiveness of the previously generated qualitative insights into the broader physical activity self-monitoring construct.

As exemplified in Study 3, a large number of comments mentioning *MyFitnessPal* had been contributed to eating disorder subreddits, which consequently enabled the generation of valuable insights into the use of this fitness tracker. While this previous analysis focused solely on *MyFitnessPal*, it is likely that comments relating to other forms of physical activity self-monitoring were also made on these subreddits.

Indeed, as found in Study 2, comments mentioning fitness trackers other than *MyFitnessPal* (e.g., *Fitbit*) had been contributed to these subreddits. The current study therefore aimed to identify and analyse comments on eating disorder subreddits relating to the broader physical activity self-monitoring construct (i.e., not solely *MyFitnessPal*) to evaluate the comprehensiveness of the previous research findings.

In order to achieve this aim, a hybrid process of deductive and inductive thematic analysis was undertaken (e.g., Fereday & Muir-Cochrane, 2006; Legare et al., 2014). Specifically, previous research findings were reviewed and consolidated to create codes before the analysis (cf. deductive thematic analysis; Braun & Clarke, 2006; Braun et al., 2016). In contrast to a purely deductive thematic analysis, the inductive component of the hybrid approach facilitated the generation of additional codes that had not been created *a priori*. Consequently, the extent to which new codes were identified in the inductive component of this thematic analysis was used to evaluate the comprehensiveness of the existing research findings. In other words, if no new codes were detected in the current study, greater confidence could be had that all important themes had been captured in the previous research.

As stated in the report of Study 6, a person's degree of focus on eating disorder recovery appears to be a key consideration in relation to physical activity self-monitoring (Studies 3 and 5; Eikey & Reddy, 2017). As such, the results of Study 6 were used to conduct the current analyses separately for three groups of commenters on eating disorder subreddits: those with a high, low or mixed focus on recovery. By conducting the thematic analyses separately for each group, a secondary aim of this study was to explore whether each theme appeared to be general to all levels of recovery-focus, or characteristic of specific groups.

9.2. Methods

9.2.1. Corpus selection

Extending Study 6, the comments comprising the corpus in this study were made between March 2017 and February 2018 (inclusive) on one of five eating disorder subreddits (*r/proED*, *r/ProEDmemes, r/EatingDisorders*, *r/eating_disorders*, *r/fuckeatingdisorders*). Code was written in *Python* (Python Software Foundation, 2017) to extract comments from the previously outlined archive (Complete Public Reddit Comments Corpus, 2018). In line with the findings of Study 6, the comments were extracted separately for three groups of commenters: low recovery-focus commenters (*n*=7,799), who only commented on low recovery-focus subreddits (*r/proED*, *r/ProEDmemes*); high recovery-focus commenters (*n*=1,619), who only commented on high-recovery focus subreddits (*r/EatingDisorders*, *r/eating_disorders*, */fuckeatingdisorders*); and mixed recovery-focus commenters (*n*=367), who commented on both low and high recovery-focus subreddits. The University of Warwick's Biomedical and Scientific Research Ethics Committee granted ethical approval for the current study (REGO-2019-2366).

In a comparable way to the extraction of comments mentioning *MyFitnessPal* (Study 3), comments related to physical activity-self-monitoring were purposively sampled from this corpus. In the previous study, comments related to *MyFitnessPal* were identified and extracted if they included at least one of three terms ('mfp', 'fitness pal', 'fitnesspal'). However, as the physical activity self-monitoring construct comprises broader forms and focuses, a more comprehensive search strategy was required. Search terms (or phrases) were therefore generated from two sources: 1) fitness tracker terms developed for Study 2, excluding the terms related to *MyFitnessPal*; and 2) terms relating to broader forms and focuses identified through the large online survey (Study 4). The terms generated from these two sources were used to create three distinct lists of search terms, which are summarised in Table 14.

Table 14. Summary of lists of search terms

	List 1: Physical activity self-monitoring terms	List 2A: Self-monitoring terms	List 2B: Physical activity terms
Description	Terms (or phrases) relating to a specific product or service that facilitates physical activity self-monitoring	Terms (or phrases) synonymous with self-monitoring	Terms (or phrases) relating to physical activity
Example search terms	fitbit pedomet strava apple health mapmy	monitor count log track filling in	run exercis tdee walk step

As presented in Table 14, *List 1* comprised terms that related to specific products that facilitate physical activity self-monitoring (e.g., *Fitbit*, pedometer, *Strava*). If the text of a comment contained one or more of the terms comprising *List 1*, the comment was extracted for the subsequent analyses (cf. Study 3 search strategy). In contrast to searching for specific products and services, the identification of comments discussing the broader forms of physical activity self-monitoring required a two-part search strategy. First, if the text of a comment did not contain a term from *List 1*, the terms from *List 2A* were used to identify comments that mentioned self-monitoring in general (i.e., not specific to physical activity). Second, following the identification of a comment including at least one term from *List 2A* (e.g., 'count'), if a physical activity term from *List 2B* (e.g., 'step') was identified within 20 characters of the self-monitoring term, the comment was extracted. For example, a comment including the phrase 'my phone counts the number of steps' would have been extracted, while a comment including the phrase 'I count the calories I eat' would not.

The terms and phrases comprising each of the lists were piloted before the final analysis (i.e., computing the number of, and reading, comments identified by each term and phrase) to ensure a balance between the sensitivity and specificity of the

search strategy. Similarly, searching for items from *List 2B* within a character-range of a term from *List 2A* was introduced to enhance the specificity of the search, and the specific number of characters (i.e., 20) was set after piloting of the search. As shown in Table 14, some terms were truncated to allow variation in the suffix (e.g., 'mapmy' would identify 'mapmyrun' and 'mapmyride'), and characters in the terms and comment text were all made lowercase to remove variation in capitalisation. In total, 33 terms from *List 1*, and 1173 unique pairings of terms from *List 2A* and *List 2B* (i.e., one term from each list) were identified in comments. All terms that identified a relevant comment are presented in Appendix H. Due to the number of identified pairings of terms from *List 2A* and *2B*, the terms are presented separately for each list rather than presenting all combinations.

9.2.2. Data analysis

In comparison to the inductive thematic analyses reported previously in this thesis (Studies 3, 4 and 5), the hybrid approach used in this study comprised deductive and inductive components (e.g., Fereday & Muir-Cochrane, 2006; Legare et al., 2014). Regarding the deductive component (cf. Braun & Clarke, 2006), thematic codes were created prior to the analysis by reviewing and consolidating findings reported in Studies 3 and 5 and other relevant qualitative research (Eikey & Reddy, 2017; Eikey et al., 2017; Honary et al., 2019). In line with the aims of this thesis, only findings related to physical activity self-monitoring were consolidated. As such, other findings identified in the previous research (e.g., overestimating energy-intake; Study 3) were not included. Overall, 48 codes were created that were grouped into five themes: 1) *Engagement and accuracy* (14 codes); 2) *Comparisons* (10 codes); 3) *Monitoring non-physical activity focuses* (8 codes); 4) *Cognitions, affect and behaviours* (12 codes); and 5) *Interpersonal factors* (4 codes). The codes are outlined in more detail in the following Results section, and are summarised in Table 16. Regarding the inductive component of the thematic analysis, if an important element of the data was not captured within the 48 codes, a new code was generated. As with the previous thematic analysis of online comments (Study 3), a critical realist epistemological perspective was adopted focusing on themes at the semantic level.

In line with the secondary aim of the current study, the thematic analyses were conducted separately for the three different groups of commenters who indicated either a low, high or mixed recovery-focus. As such, the identification of each code within each commenter group's data was also investigated.

As with the other thematic analyses reported in this thesis (Studies 3, 4 and 5), Braun and Clarke's (2006) six-step guide was used as a reference throughout these analyses, *NVivo* software (QSR International Pty Ltd., 2018) was used to facilitate the coding, and three other researchers acted as 'critical friends' (e.g., Smith & McGannon, 2017). Additionally, for ethical reasons, original *Reddit* comments were paraphrased when providing a quotation (e.g., Williams et al., 2018).

9.3. Results

9.3.1. Corpus characteristics

In total, 1,949 comments including at least one reference to physical activity self-monitoring (i.e., at least one term from *List 1* and/or one pair of terms from *List 2A* and *2B*) were identified in the eating disorder subreddits, and were made by 976 commenters. The entire corpus consisted of 206,413 words, and the average (mean) length of a comment was 106 words (*SD*=126, median=68, minimum=1, maximum=1,706).

9.3.2. Characteristics of commenter groups

Regarding the different groups of commenters, 848 (11%) of the low recovery-focus commenters made a comment relating to physical activity self-monitoring, compared to 49 (3%) and 79 (22%) of the high and mixed recovery-focus commenters, respectively. In line with the different sample sizes, 90% (1,746) of the 1,949 comments related to physical activity self-monitoring were made by the low recovery-focus commenters, compared to 3% (56) by the high recovery-focus commenters, and 8% (147) by the mixed recovery-focus commenters.

The average number and length of the comments related to physical activity self-monitoring are presented in Table 15. While the groups' commenters were indicated to contribute a similar number of comments on average, the high recovery-focus group's comments were longer on average than those made by the other groups.

Table 15. Number and length of comments contributed by each commenter group

Physical activity self-monitoring comments	*Recovery-focus group*		
	Low	*Mixed*	*High*
Average number of comments made by each commenter			
Mean	2	2	1
SD	4	1	1
Median	1	1	1
Minimum, Maximum	1:87	1:8	1:4
Average length (words) of comments			
Mean	104	105	171
SD	125	119	142
Median	68	68	127
Minimum, Maximum	1:1706	3:765	22:754

9.3.3. Themes

Table 16 presents all physical activity self-monitoring themes and codes developed for, or identified in the current study. The 48 codes presented in normal typeface were developed for the deductive component of the thematic analyses (i.e., developed from previous research findings), and the five codes presented in boldface were generated through the inductive component of the analyses (i.e., novel insights generated in this study). In line with the study's secondary aim, Table 16 presents the results of the thematic analyses separately for the low, mixed and high recovery-focus commenters. While the analyses were conducted separately to compare the codes identified within each groups' comments, the difference between the groups

in terms of the proportion of the total comments they contributed introduced potential bias into the analyses. Specifically, as the low recovery-focus commenters provided 90% of the total comments, the identification of codes within their comments was more likely than within the comments made by the other two groups. To mitigate the effect of this potential bias when addressing the secondary aim, only codes that were identified within comments made by the mixed and/or high recovery-focus groups, but not the low recovery-focus group (i.e., counter to the likely effect of the bias) are detailed further in this section.

Table 16. Consolidated physical activity self-monitoring themes and codes

Engagement and accuracy	*Recovery-focus groups in which code identified*		
	Low	*Mixed*	*High*
Do not self-monitor physical activity[a]	✓	✓	✓
Self-monitor physical activity during a bout or period of physical activity[b]	✓	-	-
Self-monitor physical activity after a bout or period of physical activity[b]	✓	-	-
Actively or deliberately self-monitor physical activity[b]	✓	✓	-
Habitually or obsessively self-monitor physical activity[c,d]	✓	✓	-
Passively or prompted to self-monitor physical activity[b,d]	✓	✓	-
Frequently self-monitor physical activity[b]	✓	✓	-
Consistently self-monitor physical activity[b]	✓	✓	-
Sporadically self-monitor physical activity[b]	-	-	-
Physical activity self-monitoring viewed as accurate, or sufficiently accurate[b]	✓	✓	-
Physical activity self-monitoring viewed as inaccurate[a,b]	✓	✓	-
Perceived accuracy of physical activity self-monitoring influences its enactment[a]	✓	✓	✓
Deliberately underestimate physical activity[a,c]	✓	✓	-
Deliberately overestimate physical activity	-	-	✓
Increase inaccuracy of physical activity self-monitoring to discredit resulting information	**-**	**-**	✓

Practicality of physical activity self-monitoring influences its enactment[b,d]	✓	✓	-
Comparisons	*Recovery-focus groups in which code identified*		
	Low	*Mixed*	*High*
Do not compare monitored physical activity to a reference value[b]	-	-	-
Compare monitored physical activity to past achievement or point in time[b]	-	-	-
Compare monitored physical activity to that of other people[b]	✓	-	-
Compare monitored physical activity to a target to reach or exceed (i.e., minimum)[b]	✓	✓	✓
Compare monitored physical activity to target not to exceed (i.e., maximum)[b]	-	-	-
Evaluation of comparison based on a small discrepancy between monitored physical activity and reference value[a]	✓	-	-
Reference value shares characteristics with individual or monitored physical activity[b]	-	-	-
Adjust reference value following comparison to monitored physical activity[b]	-	-	-
Physical activity self-monitoring increases competitiveness with self[a]	-	-	-
Physical activity self-monitoring increases competitiveness with others[a,b]	✓	-	-
Monitoring non-physical activity focuses	*Recovery-focus groups in which code identified*		
	Low	*Mixed*	*High*
General interest in self-monitoring (i.e., physical activity and other focuses)[b]	✓	✓	-

Self-monitored energy-intake used to set physical activity goal, and/or compared to energy-expenditure from monitored physical activity to calculate energy deficit[a,b,c]	✓	✓	✓
Set energy-intake goal based on combined energy-expenditure from monitored physical activity and estimates of basal metabolic rate (i.e., total daily energy-expenditure)	✓	✓	✓
Set energy-intake goal based on basal metabolic rate only and do not include energy-expenditure from monitored physical activity	✓	✓	-
Self-monitored physique influences, and/or used to evaluate effect of physical activity[b]	✓	✓	-
Satisfaction with physique influences physical activity self-monitoring[b]	-	-	-
Self-monitored sleep used to evaluate effect of physical activity[b]	-	-	-
Compare time spent being physically activity to time spent doing other activities[b]	-	-	-
Self-monitored heart rate influences, and/or used to evaluate effect of physical activity[b]	-	-	-
Self-monitored physical sensations influence, and/or used to evaluate effect of physical activity[b]	✓	-	-
Monitor aspects of the environment during physical activity	**-**	**-**	✓
Cognitions, affect and behaviours	*Recovery-focus groups in which code identified*		
	Low	*Mixed*	*High*
Awareness of physical activity[b,c]	✓	-	-
Perception of physical activity (e.g., excessive, not exercise, a bonus)[a,d]	✓	-	✓

Motivation to be physically active[a,b,d]	✓	-	-
Negative cognitions and/or affect (e.g., guilt, anxiety, eating and physique concerns)[a,b,c,d]	✓	-	✓
Positive cognitions and/or affect (e.g., satisfaction, pleasure)[a,b,c,d]	✓	-	-
Sense of security or control[b,c,d]	✓	✓	-
Restriction of energy-intake[a,c]	-	-	-
Overeating or binge-eating[a]	✓	-	-
Physical activity and purging[a,b,c]	✓	-	✓
Binge-eating and purge cycle[a]	-	-	-
Degree of focus on eating disorder recovery[a,b,d]	✓	-	✓
Cognition, affect and/or behaviours influenced relative to perceived size of discrepancy between monitored physical activity and reference value[a,b,d]	✓	-	-
Interpersonal factors	*Recovery-focus groups in which code identified*		
	Low	*Mixed*	*High*
Share physical activity information with family and/or friends[a]	-	-	-
Share physical activity information with members of eating disorder communities[a]	✓	-	-
Keep physical activity information private[a,b,d]	✓	-	-
Physical activity self-monitoring influenced by others (e.g., prevented from using device)[a,d]	-	-	-

Notes. All codes in boldface were identified in the current study.

[a]Code identified in Study 3; [b]Code identified in Study 5; [c]Code identified by Eikey and Reddy (2017); [d]Code identified by Honary and colleagues (2019); No codes related to physical activity self-monitoring identified by Eikey and colleagues (2017).

Engagement and accuracy

Across the three groups of commenters, almost all (13/14) *Engagement and accuracy* codes developed prior to the analyses (i.e., forming the basis of the deductive analyses) were identified in the comments. Specifically, while some commenters indicated that they did not monitor their physical activity, others reported engaging in it in different ways (e.g., before or after physical activity, actively or deliberately, habitually or obsessively, passively, frequently, consistently). The findings from the deductive analyses also indicated variation regarding whether physical activity self-monitoring was viewed as accurate or inaccurate. Additionally, the perceived accuracy and practicality of physical activity self-monitoring were reported to influence its enactment, and commenters indicated deliberately underestimating their physical activity.

With regard to the inductive component of the thematic analyses, two new codes were generated within the theme, and were only identified within the content contributed by the high recovery-focus commenters. First, in the context of eating disorder recovery (i.e., "when trying to reduce your physical activity"), the deliberate overestimation of physical activity was reported:

> "When you do some vigorous exercise, I would suggest adding some extra calories to the estimate." (commenter 299, high recovery-focus)

Second, when using a device or app for physical activity self-monitoring, false information was reportedly entered so that the resulting estimates were discredited and viewed as inaccurate:

> "I use the normal age, height and weight information. As those aren't correct, I don't pay much attention to the feedback" (commenter 144, high recovery-focus)

Comparisons

Within the entire data corpus, four of the ten *Comparisons* codes were identified in the comments in the deductive component of the analyses. For example, the code

'Compare monitored physical activity to a target to reach or exceed (i.e., minimum)' was illustrated by the following quotations:

> "I try hard to hit my wearable's activity goal, but I don't always reach it." (commenter 927, low recovery-focus)

> "I use a *Fitbit* so I can set goals for how many days I want to record exercise on." (commenter 970, high recovery-focus)

Specifically, the commenters reported comparing their monitored physical activity to a target to reach or exceed, or to other people. Relatedly, physical activity self-monitoring was identified as increasing competitiveness with others. Lastly, the evaluation of a comparison of one's monitored physical activity to a reference value was indicated to be based on even a small discrepancy (e.g., a negligible number of steps). Within the *Comparisons* theme, no new codes were generated through the inductive thematic analyses.

Monitoring non-physical activity focuses

The *Monitoring non-physical activity focuses* theme comprised eight codes that were developed prior to the analyses, of which four were identified in the comments. The identified codes related to the monitoring of non-physical activity focuses that provide additional information about, or influence one's physical activity. Commenters indicated a general interest in self-monitoring a range of focuses, not just those related to physical activity. While the self-monitoring of energy-intake was indicated to inform the calculation of an energy-deficit (i.e., relative to physical activity energy-expenditure), self-monitoring physique and physical sensations (e.g., pain, exhaustion) reportedly influenced and/or was used to evaluate the effects of one's physical activity.

Three additional *Monitoring non-physical activity focuses* codes were generated through the inductive component of the analyses. Two of these codes were related to energy-expenditure from one's basal metabolic rate. Specifically, commenters reported setting an energy-intake goal based on the energy-expenditure resulting from either their physical activity *and* basal metabolic rate, or *only* their basal metabolic rate (therefore discounting their physical activity energy-expenditure):

> "If you calculate your TDEE [total daily energy-expenditure], you'll put on weight if you eat more than that." (commenter 121, mixed recovery-focus)

> "I don't add any calories over my sedentary TDEE because I think physical activity energy-expenditure estimates are inaccurate." (commenter 559, low recovery-focus)

The third additional code – which was only identified within the high recovery-focus group's comments – concerned the monitoring of environmental factors during physical activity, rather than focusing on aspects of the physical activity itself:

> "Focus on the sounds, smells and sights you experience while walking, not your speed or distance." (commenter 421, high recovery-focus)

Cognitions, affect and behaviours

Of the 12 codes comprising the theme entitled *Cognitions, affect and behaviours*, ten were identified in the deductive analyses. Cognitive and affective factors that influence or are influenced by physical activity self-monitoring (or *not* self-monitoring physical activity) were reported to include: the awareness and perception of physical activity; the motivation to be physically active; positive and negative cognitions and affect (e.g., guilt, anxiety, eating and physique concerns, satisfaction, pleasure); and the sense of security or control. Regarding behaviours, engaging or not engaging in physical activity self-monitoring was indicated to influence or be influenced by: overeating or binge-eating; and physical activity and purging. Physical activity self-monitoring was also suggested to be related to one's focus on eating disorder recovery, and cognitions, affect and behaviours were indicated to be relatively influenced by the perceived size of the discrepancy between one's monitored physical activity and a reference value. Quotations illustrating *Cognitions, affect and behaviours* codes are provided below:

> "You have to turn your attention to recovery instead of counting steps or calories." (commenter 826, high recovery-focus)

> "One day my *Fitbit* wasn't charged and I freaked out. I had to wait until it was charged and logging my steps before I could do anything else." (commenter 22, low recovery-focus)

No new codes were added to this theme through the inductive component of the analyses.

Interpersonal factors

Regarding the four codes comprising the *Interpersonal factors* theme, two of these were identified in the data corpus. Contrastingly, the two codes reflected that the commenters shared information about their physical activity with people in eating disorder communities (e.g., on the subreddits), or kept this information private. The following two quotations illustrate each of these codes, respectively:

> "I also have a *Fitbit*. Send me a message if you want to be friends on it." (commenter 374, low recovery-focus)

> "Loads of my friends use *Fitbit*, but I don't let them see anything I log." (commenter 655, low recovery-focus)

The inductive component of the analyses did not lead to the generation of any new codes within the *Interpersonal factors* theme.

9.4. Discussion

Adding to the findings of previous research (e.g., Eikey & Reddy, 2017; Eikey et al., 2017; Honary et al., 2019), the overall aim of this thesis was to generate qualitative insights into the conceptualisation of physical activity self-monitoring in relation to eating psychopathology and compulsive exercise. By consolidating the findings from the existing research with those identified in the studies reported in this thesis, the primary aim of the current study was to evaluate the comprehensiveness (i.e., saturation) of the overall qualitative insights. This was achieved by conducting hybrid (i.e., deductive and inductive) thematic analyses of 1,949 comments that were related to physical activity self-monitoring and contributed to eating disorder

subreddits. Addressing a secondary aim, using findings from Study 6, three thematic analyses were conducted to compare groups of commenters indicating either a low, high or mixed focus on eating disorder recovery.

Out of 48 *a priori* codes comprising five themes (*Engagement and accuracy*; *Comparisons*; *Monitoring non-physical activity focuses*; *Cognitions, affect and behaviours*; *Interpersonal factors*), the deductive thematic analyses identified comments within the corpus that reflected 33 of these codes. However, inductive thematic analyses resulted in the generation of five additional codes that had not been identified in the previous research. Consequently, while the majority of the qualitative insights in this study had been identified in previous research (i.e., the insights were captured in the codes developed for the deductive analyses), the identification of novel insights indicated that the previous research findings were not saturated (e.g., Guest et al., 2006). As the primary aim of this study was to assess the comprehensiveness of the previous research findings, and to avoid repetition, the five codes identified in this study are discussed further in the general discussion of the thesis presented in the next chapter. However, in brief, these five codes related to: deliberately overestimating physical activity; increasing the inaccuracy of physical activity self-monitoring; considering energy-expenditure from metabolic processes either together with, or separately from energy expended through physical activity; and monitoring environmental factors during physical activity.

The comparison of the three groups of commenters (i.e., indicating a low, high or mixed recovery-focus) was limited due to the large differences in the number of comments that each group contributed. Specifically, the low recovery-focus commenters contributed 90% of the comments, which is, perhaps, unsurprising given the finding that fitness trackers were more frequently mentioned in the least recovery-focused eating disorder subreddit (Study 2). Due to the bias that was likely introduced by the differences in sample size, a conservative approach to the comparisons was adopted, and only differences that were counter to the potential bias (i.e., codes present in the high or mixed, but not the low recovery-focus comments) were outlined. Three codes fulfilled this criterion, all of which were novel insights inductively generated in the current study, and identified in the high

recovery-focus group's comments. As a result, this finding suggests that the three codes represent aspects of physical activity self-monitoring that are specific to people with a high focus on eating disorder recovery (i.e., deliberately overestimating physical activity, increasing the inaccuracy of physical activity self-monitoring, and monitoring environmental factors during physical activity). As mentioned above, these aspects of physical activity self-monitoring will be discussed further in the general discussion of the thesis (chapter 10).

In addition to the difference in sample sizes restricting the comparisons between commenter groups, the study reported in this chapter is subject to further limitations. First, it is possible that not all comments that were semantically related to physical activity self-monitoring were identified by the search strategy. For example, a commenter might have used a term for monitoring that was not included in *List 2A*, or they might have made a typographic error. Indeed, this limitation also applied to Studies 2 and 3. In contrast to identifying comments related to physical activity self-monitoring in this study, the previous two studies focused on fitness trackers. Reflecting the breadth of physical activity self-monitoring, this construct might be expressed in a wider variety of ways than the use of fitness trackers. As such, it is possible that the search strategy in the current study failed to identify more comments than in the previous two studies. However, as with these other studies, the large corpus of text used for the analyses makes it unlikely that unidentified but relevant comments would contribute novel insights. This is particularly the case given the comprehensiveness of the lists of search terms, which were informed by a previous extensive search for fitness tracker terms (Study 2), and broader physical activity self-monitoring terms derived from a large online survey (Study 4). Another limitation concerns codes that reflected the *lack* of engagement in physical activity self-monitoring, such as 'Sporadically self-monitor physical activity' and 'Do not compare monitored physical activity to a reference value'. While neither of these codes were identified in the corpus, this might simply reflect that commenters are less likely to discuss unprompted what they do not do, compared to discussing what they do (e.g., 'Frequently self-monitor physical activity'). However, through the

triangulation afforded by the different data sources (e.g., interviews) reported in this thesis, this limitation might have less impact on the overall findings of the thesis.

As this study represents the consolidation of the findings from the preceding research in this thesis, the codes identified and developed in this study (and their implications) will be discussed in detail in the next chapter. However, a distinct implication of the current study is that further research might be warranted in a population with a high focus on eating disorder recovery. Specifically, despite the relative paucity of comments (56, 3% of all comments) contributed by the high recovery-focus group, three of the five novel insights generated in this study were only identified in this sample's comments. As such, it is possible that aspects of physical activity self-monitoring that are particularly indicative of people with a high focus on eating disorder recovery remain unidentified.

9.5. Summary

The main aim of this thesis was to inform the conceptualisation of physical activity self-monitoring in relation to eating psychopathology and compulsive exercise. Overall, the findings of the current study suggested that, while the preceding studies reported in this thesis generated a variety of qualitative insights, important aspects of physical activity self-monitoring might still remain unidentified. This might particularly be the case for people with a high focus on eating disorder recovery. Having consolidated the main findings of this thesis in the current study, the next chapter discusses these insights in greater detail, as well as outlining the overall implications, limitations and suggested future directions of the research presented in the preceding chapters.

10. General Discussion

10.1. Overview of aims of thesis

The preceding studies reported in this thesis primarily aimed to answer the following question:

> *How should physical activity self-monitoring be conceptualised in relation to eating psychopathology and compulsive exercise?*

The rationale for posing this question came from several lines of research (chapters 1 to 3). In brief, in contrast to monitoring one's physique (i.e., body checking; e.g., Reas et al., 2002), there is a paucity of research investigating how the monitoring of behaviours that affect one's physique (e.g., diet, physical activity) is related to eating psychopathology. Furthermore, the few studies addressing this topic have tended to focus narrowly on the use or non-use, or the frequency of use of diet and fitness trackers (e.g., Simpson & Mazzeo, 2017). Consequently, there was a clear need to develop a broader conceptualisation of the self-monitoring of physique-related behaviours. While several such behaviours are important to consider in relation to eating psychopathology (e.g., eating, purging), this thesis focused on the self-monitoring of physical activity for several reasons. First, physical activity is often neglected in relation to eating disorders (Touyz et al., 2017). Second, compared to the use of diet trackers, the use of fitness trackers is indicated to be more strongly associated with eating psychopathology (Plateau et al., 2018; Simpson & Mazzeo, 2017). Third, patients with eating disorders have been indicated to under-report their exercise (Bezzina et al., 2019; Bratland-Sanda et al., 2010). Last, while physical activity self-monitoring had been viewed as characteristic of compulsive exercise in earlier conceptualisations of the construct (e.g., Adkins & Keel, 2005), it is not assessed in currently used measures of compulsive exercise (e.g., CET; Taranis et al., 2011).

In order to address this research question, six studies were conducted (chapters 4 to 9). In order to mitigate the limitations of any one data source (i.e., triangulation; e.g., Erzberger & Prein, 1997), three sources of data were used across these studies: a large online survey, a series of interviews, and comments made on online eating

disorder forums. The specific ways in which these studies addressed the research question are captured in the following aims:

1) Elucidate the ways in which people with high levels of eating psychopathology engage with fitness trackers (Studies 2 and 3).

2) Identify the varied forms and focuses of physical activity self-monitoring (Study 4).

3) Investigate the ways in which compulsive exercisers engage in physical activity self-monitoring (Study 5).

4) Generate and evaluate the comprehensiveness of insights into how people with high levels of eating psychopathology engage in physical activity self-monitoring (Studies 6 and 7).

10.2. Summary of research findings

For the final study reported in this thesis (Study 7), the insights generated through the preceding studies and previous qualitative research (Eikey & Reddy, 2017; Eikey et al., 2017; Honary et al., 2019) were consolidated into five themes: *Engagement and accuracy*; *Comparisons*; *Monitoring non-physical activity focuses*; *Cognitions, affect and behaviours*; and *Interpersonal factors*. A summary of the findings relating to each theme is presented in Table 16, and the insights relating to each of these themes are now discussed in turn.

10.2.1. Engagement and accuracy

A key rationale behind this thesis' research question was that studies in the area of eating psychopathology tend to focus narrowly on the use of devices and apps that facilitate physical activity self-monitoring. As a result of this narrow focus, the experiences of people for whom physical activity self-monitoring is problematic might be neglected if they use a form other than a fitness tracker. For example, instead of using technologies to self-monitor, a person might alternatively use paper records or their memory (Abril, 2016). Reflecting arguments in the field of behaviour

change research (e.g., Dombrowski et al., 2016) and meta-analytic evidence (Harkin et al., 2016), a consideration of the varied forms of physical activity self-monitoring is vital, as one form might influence one's behaviour differently from another.

In line with the importance of form, the survey responses from 3,495 people (Study 4) enabled a comprehensive overview to be provided into the varied ways in which an individual can monitor their physical activity. The different forms were distinguished in terms of whether physical activity self-monitoring could be performed using only a person's mental processes and senses (e.g., 'being aware'), or whether it necessitated the use of an instrument (e.g., 'wearable technology', 'pen and paper'). Additionally, across both of these categories of self-monitoring, respondents indicated recording their physical activity (e.g., 'remembering what I've done', keeping a 'written log' of exercises), as well as quantifying it (e.g., 'counting situps', using 'step counters', 'timing my bike rides').

The survey's insights concerning the forms of physical activity self-monitoring were not consolidated into the themes developed for the final study (Table 16). The reason for this was because, together with a previously developed set of fitness tracker terms (Study 2), the forms identified in the survey were instead used to identify relevant comments in the final study (Study 7). However, in this general discussion, the forms of physical activity self-monitoring are considered together with insights into *Engagement and accuracy*, as, in practice, these aspects of self-monitoring are interrelated. For example, the practicality of self-monitoring physical activity was reported to influence its enactment (cf. Studies 5 and 7), such as an interviewee with a high level of compulsive exercise reporting not monitoring exercise with their phone, due to concern that it might fall out of their pocket. Similarly, participants in a previous study reported not using an app for self-monitoring, as it affects the battery performance of their phone (Honary et al., 2019).

While the practicality of self-monitoring physical activity has implications for future research, it is, arguably, unlikely to be directly related to one's level of eating psychopathology. In contrast, several studies reported in this thesis suggest that the perceived accuracy – and, by implication, the quantification (cf. Chang et al., 2017) – of physical activity self-monitoring is particularly important to consider. As with the

practicality of physical activity self-monitoring, its perceived accuracy was reported to influence its enactment, with inaccurate monitoring being disregarded (Studies 3 and 7). In addition to the participants and commenters varying in terms of their perceived accuracy of the monitoring (e.g., accurate, sufficiently accurate, inaccurate), they also reported deliberately misestimating their physical activity. Across several studies (3, 4 and 7), as well as being observed in other research (Eikey & Reddy, 2017), individuals reported deliberately underestimating their physical activity. Such a finding is in line with patients with anorexia nervosa typically underreporting their exercise (Bezzina et al., 2019; Bratland-Sanda et al., 2010). This pattern is of concern, as it is in a direction that potentially encourages higher levels of exercise. Further evidence for misestimation being important comes from novel findings from the final study of this thesis (Study 7). Specifically, within the comments from individuals who appear to have a high focus on eating disorder recovery, the deliberate *over*estimation of physical activity was reported. The same group of individuals (i.e., with a high recovery-focus) also reported deliberately increasing the inaccuracy of physical activity self-monitoring in order to discredit the resulting information. Taken together, and in line with the findings of previous research (e.g., Bezzina et al., 2019), the findings from these studies suggest that the extent to which one's reporting of physical activity is accurate (or seen as accurate) is potentially related to one's level of eating psychopathology, and/or one's degree of focus on eating disorder recovery. Indeed, in Pennesi and Wade's review of models of eating psychopathology (2016), they identified perfectionism as a core construct within two models (Fairburn, 2008; Treasure & Schmidt, 2013). Perfectionism is typically characterised as involving 'hypervigilant monitoring', which involves judging one's success or failure in achieving a goal based on a small discrepancy (e.g., failing a weight-loss goal by 1 kilogramme; Shafran, Cooper, & Fairburn, 2002). Due to such judgements of success or failure being based on small discrepancies, the desire for a high accuracy of one's self-monitoring is therefore potentially related to a perfectionistic thinking style. As detailed above, perfectionism is typically characterised as comparing oneself to a standard (Shafran et al., 2002). As such, further consideration of perfectionistic thinking styles is presented in the following subsection concerning the theme *Comparisons*.

In terms of behavioural aspects of engagement (cf. Perski et al., 2016; Tougas et al., 2015), the frequency and consistency of self-monitoring physical activity were identified as being crucial considerations. Other than the dichotomous use of fitness trackers (e.g., Levinson et al., 2017), only the frequency of use appears to have been investigated (Hefner et al., 2016; Plateau et al., 2018), meaning that a potential relationship between the consistency of physical activity self-monitoring and eating psychopathology remains unidentified. In light of the rigid exercise patterns that are argued to be characteristic of compulsive exercise (e.g., Taranis et al., 2011), the consistency of physical activity self-monitoring is, potentially, especially important to investigate. In addition to the frequency and consistency of engagement, other aspects of engagement identified as being important considerations in the conceptualisation of physical activity self-monitoring include: the extent to which it is performed actively or passively (e.g., notified by a device; cf. Harkin et al., 2016); and whether it is enacted during or after physical activity.

Overall, the varied forms and aspects of engagement in physical activity self-monitoring support its conceptualisation as a multifaceted construct (cf. Dombrowski et al., 2016; Perski et al., 2016). While behavioural aspects of engagement are important (e.g., frequency, consistency), several insights related to the accuracy of physical activity self-monitoring suggest that this is a particularly important aspect to consider in relation to eating psychopathology and compulsive exercise. The implications of these findings are discussed in greater detail in the next section (10.3.).

10.2.2. Comparisons

Within control theory (Carver & Scheier, 1982), self-monitoring is defined as the process of perceiving one's current state, whether a behaviour (e.g., physical activity), or a behavioural outcome (e.g., Michie et al., 2015). Following this, the discrepancy resulting from the comparison of one's perceived state to a reference value is argued to influence behaviour in an attempt to reduce the discrepancy (i.e., forming a feedback loop). Reflecting the empirical support for control theory (e.g., Prestwich et al., 2016), several insights into physical activity reference values, and comparisons to these were generated in the preceding studies. Mirroring the

distinction made by Harkin and colleagues (2016), reference values were identified across the current studies that related to comparing one's current physical activity to that of other people, one's past performance, and a desired state.

As detailed by Pennesi and Wade (2016), comparing one's body shape and weight to others is a core construct in one model of eating psychopathology (Yamamiya et al., 2008). Extending this, comparisons to others in relation to behaviours that affect one's physique also appear to be important to consider in relation to eating psychopathology. The findings of this thesis indicated that, when comparing to other people and in line with social comparison theory (Festinger, 1954), the comparisons were reportedly made to people – either specific people, or ideas about others (e.g., 'benchmarks') – with whom the person monitoring shared characteristics (e.g., age, gender). Connected with making comparisons to others, physical activity self-monitoring was viewed as increasing competitiveness with other people (Studies 3, 5 and 7). While only observed in the study concerning *MyFitnessPal* in this thesis (Study 3), competitiveness with oneself, which implies a comparison to one's previous performance, was also perceived to be increased by monitoring one's physical activity. In relation to comparisons to a desired level of physical activity, these targets could be distinguished in terms of whether the target represented a minimum (i.e., to reach or exceed), or a maximum (i.e., not to exceed). While the former was identified in more than one study (Studies 5 and 7), making a comparison to a maximum level of physical activity was only identified in the interviews with people with high levels of compulsive exercise (Study 5). In a similar way to the deliberate overestimation of physical activity highlighted in the previous subsection, comparing to a maximum level was reportedly undertaken with the aim, although not always successfully, of limiting physical activity.

When comparing one's physical activity to a reference value, two studies in this thesis (Studies 3 and 7) observed that the evaluation was based on a small discrepancy (e.g., a few steps) between the perceived and reference physical activity. As with the perception of accuracy outlined in the previous subsection, this finding also implies the importance of the quantification of physical activity self-monitoring. Indeed, reference values were often expressed quantitatively throughout the studies (e.g.,

"get it up to, like, 20,000 [steps]"; Study 5). Additionally, in line with suggestions from previous research (Eikey & Reddy, 2017; Levinson et al., 2017; Linardon & Messer, 2019; Simpson & Mazzeo, 2017), a further implication of this finding is that perfectionism is a crucial consideration in relation to physical activity self-monitoring. As discussed in the previous subsection, perfectionism is a core factor within models of eating psychopathology (Pennesi & Wade, 2016), and a central aspect of the construct is argued to be the dichotomous evaluation of performance (Shafran et al., 2002). Such dichotomous evaluation is clearly reflected in small discrepancies being used to evaluate a comparison, and might explain why the accuracy of physical activity self-monitoring was identified as a crucial aspect to consider. However, as highlighted in debates regarding the conceptualisation of perfectionism (e.g., Hewitt, Flett, Besser, Sherry, & McGee, 2003) it is, perhaps, unsurprising that perfectionism is implicated within physical activity comparisons, as the model proposed by Shafran and colleagues is argued to overlap with the process outlined by control theory (Carver & Scheier, 1982). Regardless of this debate, Shafran and colleagues' emphasis on the dichotomy of comparative evaluations is supported as being an important consideration with regard to physical activity self-monitoring. This importance is further emphasised by compulsive exercise being found to directly and indirectly mediate the relationship between clinical perfectionism and eating psychopathology in a cross-sectional analysis (Egan et al., 2017).

Overall, the insights generated in this thesis into physical activity comparisons can clearly be situated within the self-regulatory process of control theory (Carver & Scheier, 1982), which supports this theory as being a useful framework to guide research in this area. Indeed, the feedback loop that is central to control theory was reflected in the observations that: reference values were adjusted based on comparative outcomes (Study 5); and behaviours were enacted that theoretically reduce the perceived discrepancy resulting from a comparison (detailed further in subsection 10.2.4.). However, it should be noted that self-monitoring physical activity in the absence of a reference value was explicitly mentioned during the interviews with people with high levels of compulsive exercise (Study 5). As such, from a control theory perspective, as self-monitoring without a reference value would prevent a

comparison from being made, this insight suggests that physical activity self-monitoring might be performed for reasons other than self-regulation.

10.2.3. Monitoring non-physical activity focuses

The responses provided by completing the sentence "I monitor and keep track of my physical activity by…" in the survey (Study 4) indicated that the participants monitored a variety of focuses that were not directly related to physical activity (i.e., aspects of physiology, physique, ingestion, and physical and mental state). Furthermore, in both the interviews and final study (Studies 5 and 7), individuals reported a general interest in monitoring (e.g., "[…] I like logging things. I like record keeping, it's fun."). While the survey indicated the diversity of non-physical activity focuses, the other qualitative studies in this thesis (Studies 3, 5 and 7) helped elucidate how monitoring each of these focuses was related to physical activity self-monitoring.

Reflecting the functionality of *MyFitnessPal*, the self-monitoring of diet was identified in Study 3. In combination with the insights from other studies in this thesis (Studies 5 and 7) and research by Eikey and Reddy (2017), an understanding of how dietary self-monitoring is related to physical activity self-monitoring was developed. Specifically, self-monitoring diet and physical activity appeared to be linked when they were considered in terms of their energy (i.e., self-monitoring energy-intake and energy-expenditure, respectively). This insight is unsurprising, as, for example, exercising to 'burn calories' is a key aspect of compulsive exercise (Taranis et al., 2011). Due to focusing on themes at the semantic level (i.e., explicit within the data; cf. Braun & Clarke, 2006), energy-expenditure was categorised as a physiological focus in the interpretation of the survey's findings (Study 4), as, at a superficial level, it represents the energy required for *any* physical function (e.g., exercise, breathing, circulation). This interpretation was deemed appropriate, as categorising energy-expenditure as a physical activity focus would neglect the consideration of the energy expended at rest (i.e., basal metabolic rate). Having identified comments including the term 'tdee' (i.e. total daily energy-expenditure, from both physical activity and basal metabolic rate), the final study in this thesis (Study 7) provided additional insights that clarified how energy-intake and energy-expenditure are seemingly

compared. Specifically, the commenters reportedly compared their energy-intake to the energy expended through either: 1) physical activity and basal metabolic rate (i.e., total daily energy-expenditure); 2) physical activity only; or 3) basal metabolic rate only. Regarding the first type of comparison, if one's daily energy-intake were the same as one's total daily energy-expenditure, this comparative outcome could reasonably be interpreted as one's physiological energy requirements being met. However, if no discrepancy were observed when comparing one's total energy-intake to only the daily energy-expenditure from *either* physical activity *or* basal metabolic rate (the second and third types of comparisons, respectively), a large deficit in one's physiological energy requirements could be assumed. Consequently, using the energy expended through *either* one's physical activity *or* basal metabolic rate as a target (i.e., reference value) for one's energy-intake, and continually achieving this target, could facilitate weight-loss. Similar weight-loss would also be possible, if one's energy-intake is consistently used as a target for physical activity (i.e., 'calories in, calories out'). When making comparisons to one's energy-intake, this discounting of the energy expended through either physical activity or basal metabolic rate is of obvious concern in relation to eating psychopathology. Indeed, given the deliberate underestimation of physical activity reported previously, if this approach to monitoring were coupled with a discounting of energy expended through one's basal metabolic rate, the potential effect on weight-loss would be amplified. In line with this distinct role of monitoring physical activity energy-expenditure, these findings suggest that this focus of physical activity self-monitoring should be considered separately from the monitoring of other aspects of physical activity (e.g., distance, duration).

In line with this indirect effect of physical activity self-monitoring on one's weight, Plateau and colleagues (2018) found that people who reported using fitness trackers for weight-control had higher levels of weight-control exercise (i.e., an aspect of compulsive exercise; Taranis et al., 2011), dietary restraint, and concerns about body shape and weight. The interviews with people with high levels of compulsive exercise (Study 5) provided further support for the importance of one's physique as a motivation to monitor one's physical activity. For example, one interviewee stated

that, due to being satisfied with their physique, they felt no need to monitor their physical activity. In addition to monitoring one's sleep, heart rate and physical sensations (e.g., 'tired', 'ache'), monitoring one's physique was also indicated to evaluate the effects of, and influence one's physical activity. For example, an interviewee described assessing their physique to determine whether they should exercise more (Study 5).

The insights outlined in this thesis indicate that the self-monitoring of physical activity, diet and physique are closely related. Indeed, the interrelation of self-monitoring these focuses is aligned with Kruglanski and colleagues' theory of goal systems (2002). For example, in order to lose weight, one might increase one's physical activity. Therefore, while self-monitoring weight would directly provide information about changes in one's weight, it would also indirectly provide information about one's level of physical activity. However, the information regarding physical activity might be less reliable, as one's weight might also be affected by other behaviours (e.g., eating). Overall, while monitoring one's physique (i.e., body checking) is often a core construct within models of eating psychopathology (e.g., Fairburn, 2008), the findings detailed above suggest that the self-monitoring of behaviours that affect one's physique should also be considered within these models.

While the previous focuses outlined in this subsection all relate to one's body, the monitoring of two other focuses in relation to physical activity was also observed in the research presented in this thesis. Of importance, both of these were discussed in relation to recovering from an eating disorder, or reducing excessive exercise. First, one interviewee indicated that, through comparing the time spent exercising to that spent studying, they identified an excessive level of exercise and adjusted their goals accordingly (Study 5). Second, within the comments provided by commenters with a high level of focus on eating disorder recovery, advice was given to focus on aspects of the environment during physical activity, such as the 'sounds, smells and sights' (Study 7). These two findings will be discussed further in relation to the implications for eating psychopathology prevention and intervention (subsection 10.3.2.).

10.2.4. Cognitions, affect and behaviours

Through the studies comprising this thesis and previous qualitative research (Eikey & Reddy, 2017; Eikey et al., 2017; Honary et al., 2019) several cognitive, affective and behavioural factors were indicated by commenters and participants to influence, or be influenced by physical activity self-monitoring. As such, these factors can be considered as potential antecedents or consequences of physical activity self-monitoring, respectively. However, from a control theory perspective (Carver & Scheier, 1982), self-regulation is conceptualised as a feedback loop, meaning that such cognitive, affective and behavioural factors can be both antecedents and consequences. As such, although reference is made to these factors influencing or being influenced by physical activity self-monitoring in this subsection, they should be framed as forming part of the feedback loop and therefore potentially representing both antecedents and consequences.

In line with self-monitoring being synonymous with the perception of one's current state (Carver & Scheier, 1982), a greater awareness of one's physical activity resulting from its monitoring was commonly reported (Studies 5 and 7; Honary et al., 2019). Furthermore, an individual's perceived awareness of their physical activity was described as influencing their self-monitoring of it (e.g., a high level of awareness removing the need to monitor), which reflected the cyclical nature of self-regulation (cf. Carver & Scheier, 1982). As supported through the interviews with compulsive exercisers (Study 5), the rigid patterns of exercise that characterise compulsive exercise (cf. Taranis et al., 2011) represent an important consideration in terms of physical activity self-monitoring. Specifically, as habits might be developed through the rigid, repeated patterns of exercise (Verplanken & Orbell, 2003), more automatic processes of self-regulation might be enacted rather than reflective processes, such as self-monitoring (cf. Rothman et al., 2009). Indeed, such a pattern was indicated by interviewees who reported deliberately monitoring their physical activity when starting a new pattern of exercise (i.e., being less aware of the nature of the exercise), and subsequently stopping or reducing their monitoring when it became more habitual (i.e., being more aware of the nature of the exercise).

Related to the awareness of physical activity, and reflecting previous points in this section, the monitoring of one's physical activity (and its comparison to reference values) was also shown to influence its framing. For example, when discounting the energy-expended through exercise, commenters who used *MyFitnessPal* framed this aspect of physical activity as a 'plus' (Study 3). Furthermore, following comparison to other people or the time spent doing other activities, individuals reporting high levels of physical activity described this as, for example, 'unhealthy' (Study 5). Last, interviewees also indicated that, without monitoring their physical activity, they would not see themselves as having been active ("[not using a smartwatch] would feel like […] you didn't do the run because it hasn't recorded it."; Study 5). Such a finding suggests that the underestimation of physical activity is, perhaps, not only deliberate, but reflective of one's perception of physical activity and whether or not it 'counts'. For example, in relation to eating psychopathology, patients with anorexia nervosa were found to underreport their light physical activity, which was interpreted as these patients potentially having a different definition of what constitutes 'light activity' (Bezzina et al., 2019).

In relation to physical activity self-monitoring, a diverse range of cognitive and affective factors that had been reported in previous research (e.g., Eikey & Reddy, 2017; Honary et al., 2019) were also identified across the studies in this thesis. Specifically, these cognitions and affect were both positive (e.g., satisfaction, pleasure, reassurance) and negative (e.g., guilt, anxiety, concerns about eating and one's physique). Of particular importance was the support for physical activity self-monitoring being conceptualised as a safety-seeking behaviour (Pallister & Waller, 2008; Salkovsis, 1991). In other words, as a safety-seeking behaviour, an individual would monitor their physical activity to increase their sense of control (e.g., feeling 'reassured'; Study 3), and to alleviate feelings of anxiety, and other negative cognitions and affect (e.g., 'If I can't check [my phone], I feel like something bad is going to happen'; Study 5). However, safety-seeking behaviours are viewed as being counter-productive, instead maintaining anxiety around the situation the individual aims to control. Indeed, in the case of fitness trackers, it is suggested that the false sense of security they provide might lead to individuals becoming overly dependent

on the apps and devices (Piwek, Ellis, Andrews, & Joinson, 2016). Consequently, reflecting anxiety playing a crucial role in relation to eating psychopathology (e.g., Pallister & Waller, 2008), the way in which physical activity self-monitoring triggers and/or alleviates anxiety is important to investigate further. More generally, the potential relationship between physical activity self-monitoring, and the cognitive and affective factors detailed above – both general (e.g., anxiety) and related to one's physique (e.g., concerns about body shape and weight) – are in line with the emotion regulation difficulties that are a core factor within most models of eating psychopathology (cf. Pennesi & Wade, 2016). As such, physical activity self-monitoring might represent another behaviour that is argued to be enacted by people with high levels of eating psychopathology to avoid negative emotions (Cooper et al., 2009; Fairburn, 2008; Neumark-Sztainer et al., 2003; Treasure & Schmidt, 2013; Wildes et al., 2010; Wilfey et al., 2000).

As outlined in the previous subsection and in line with goal systems theory (Kruglanski et al., 2002), it was common that individuals reported monitoring physical activity in addition to other related behaviours (e.g., eating) and behavioural outcomes (e.g., changes in one's physique). As such, it was unsurprising that commenters and participants detailed how physical activity self-monitoring affected their performance of several behaviours (e.g., physical activity, overeating, restriction, purging). However, the ways in which these behaviours were related to physical activity self-monitoring varied, such as the direction of the effect. For example, comparisons to others were reported to assist some individuals to reduce their physical activity, but encourage competition and increase physical activity in others. Due to the variability in the effect, it is therefore important to consider how the other factors summarised in this section influence the effect of physical activity self-monitoring on behaviours, and, consequently, behavioural outcomes (e.g., changes in one's physique).

One such factor that has been consistently indicated to be a key consideration in relation to physical activity self-monitoring is one's focus on eating disorder recovery (Studies 2, 3, 4 and 7; Eikey & Reddy, 2017; Honary et al., 2019). For example, variation in the effect of comparing one's physical activity to others might be

explained by one's degree of recovery-focus, as such comparisons were viewed as supportive of recovery by an interviewee wanting to keep their physical activity "in check" (Study 5). Furthermore, specific aspects of physical activity self-monitoring were only observed in comments made by people who were indicated to have a high focus on recovery (e.g., overestimating physical activity; Table 16). The implications of the findings regarding a person's focus on eating disorder recovery are outlined further in relation to the implications for eating psychopathology prevention and intervention (10.3.2.).

10.2.5. Interpersonal factors

A last set of insights, albeit fewer in number than in the previous subsections, concerns the relation between physical activity self-monitoring and interpersonal factors. Poor interpersonal relationships are a core construct within several models of eating psychopathology (Fairburn, 2008; Lyon et al., 1997; Neumark-Sztainer et al., 2003; Treasure & Schmidt, 2013; Wilfey et al., 2000), although findings specifically related to the quality of interpersonal relationships were not observed in the studies comprising this thesis. In contrast, a characteristic of compulsive exercise, for which there is a consensus (Noetel et al., 2017), is that it is often performed in secret. As such, the finding across several studies that physical activity self-monitoring is also reported to be undertaken in secret was consistent with this characteristic (Studies 3, 5 and 7; Honary et al., 2019). However, there was also an indication that some individuals shared information with their family and/or friends, or members of eating disorder communities (Studies 3 and 5). The latter is of particular concern if people share their information in a pro-eating disorder community, as this could lead to its members encouraging each other's pathological behaviours. Another finding was that individuals reported that their physical activity self-monitoring was influenced by others. In the case of *MyFitnessPal*, this took the form of interventions within the app that limited the usage of certain functionality (Study 3). Similarly, a clinician consulted by Honary and colleagues (2019) stated that, in clinics, they discouraged the use of fitness trackers by their patients. As *MyFitnessPal*'s intervention was indicated to be viewed negatively (e.g., 'punitive'), patients might also view similar interventions from clinicians in a negative way.

10.2.6. Summary

Before discussing the implications, limitations and future directions of the research presented in this thesis (sections 10.3. to 10.5.), this section will summarise the key aspects of physical activity self-monitoring that should be considered in relation to eating psychopathology and compulsive exercise, as developed through the results of this thesis. In line with recommended practice for construct conceptualisation (e.g., Clark & Watson, 2019), this involves conceptualising what it *is*, and what it *is not*.

In terms of what physical activity self-monitoring is, several aspects of the construct were supported to be important considerations in relation to eating psychopathology and compulsive exercise. First, the form of physical activity self-monitoring, and whether it can be performed using only one's mental processes (e.g., remembering, mentally counting), or whether it requires use of an instrument (e.g., fitness trackers, pen and paper). Whether or not information is recorded and/or quantified should also be considered in relation to the form, as well as its practicality (e.g., whether it is appropriate for a specific type of exercise). Second, the accuracy, or perceived accuracy, of physical activity self-monitoring is a key factor, as well as the misestimation of physical activity (e.g., underestimating, overestimating), which is suggested to be a deliberate strategy. Third, aspects of engagement that appear particularly important are the frequency and consistency of monitoring one's physical activity, as well as whether it is performed actively or passively, and during or after being physically active. Last, regarding specific focuses, the monitoring of energy-expenditure from physical activity should be distinguished from other aspects of physical activity (e.g., distance, duration).

Regarding what physical activity self-monitoring is not, as argued throughout this thesis, the reference values against which one's physical activity is compared should be considered separately from self-monitoring (cf. Carver & Scheier, 1982). First, in line with a previous distinction (Harkin et al., 2016), three types of reference value should be distinguished, comparisons to: one's past performance; other people, whether specific individuals or ideas about people's physical activity in general; and ideal targets, and whether these represent a minimum or maximum amount of

physical activity. Second, as with self-monitoring, the quantification of reference values should also be considered, and, relatedly, the extent of the discrepancy that results from the comparison. Third, reference values related to energy-expenditure should be distinguished from those related to other aspects of physical activity. Furthermore, whether or not a target energy-expenditure for physical activity accounts for the energy expended through one's basal metabolic rate appears to be crucial consideration in relation to eating psychopathology. Fourth, the monitoring of body-related focuses are indicated to either directly inform reference values for one's physical activity (e.g., energy-intake), or are used to evaluate the effect of physical activity (e.g., physique, physiology, physical and/or mental sensations). Last, the monitoring of focuses that are unrelated to one's body appear to similarly inform one's physical activity reference values (e.g., comparing to time spent studying).

Other factors that should be considered distinct from physical activity self-monitoring are psychosocial in nature. First, in relation to comparisons, perfectionistic and dichotomous thinking styles are of potential importance in the evaluation of one's physical activity performance relative to a reference value. Second, one's awareness of physical activity, and how self-monitoring influences, and is influenced by such awareness is crucial to understand, particularly in relation to the rigid patterns of physical activity characteristic of compulsive exercise. Other important cognitive and affective factors indicated to result from, and influence physical activity self-monitoring include satisfaction, anxiety, guilt, and eating and physique-related concerns. Similarly, the need to examine the relationship between physical activity-related comparisons and weight-control behaviours (e.g., physical activity, overeating, restriction, purging) and their outcomes (e.g., body weight) is apparent. Third, with regard to experiences of anxiety in relation to physical activity self-monitoring, the extent to which physical activity self-monitoring is used to alleviate these feelings, and provide a sense of security or control seems to be particularly vital to take into account. Fourth, the individual's framing of physical activity should be considered, particularly whether it 'counts' as exercise, and whether it is seen as 'excessive' or 'unhealthy'. Fifth, interpersonal factors to examine include whether or not: information about physical activity is shared;

physical activity self-monitoring is concealed; and physical activity self-monitoring is limited by others (e.g., devices, clinicians). Last, and, perhaps, most obviously, an individual's degree of focus on eating disorder recovery has consistently been shown to be a particular important consideration in relation to physical activity self-monitoring.

10.3. Implications

The previous section highlighted the key insights that are important to consider regarding physical activity self-monitoring in relation to eating psychopathology and compulsive exercise. The implications of these and additional findings for research, prevention and intervention, and online communities are now discussed.

10.3.1. Research

As outlined in the first chapter, when conceptualising a construct, a neglect of substantive validity compromises the evidence that is generated in the subsequent phases of the validation process (e.g., Clark & Watson, 2019; Dixon & Johnston, 2019; Flake et al., 2017; MacKenzie et al., 2011). Furthermore, the chapter outlined the benefit to science of assessing elemental constructs, which represent the parsing of a more complex construct to reduce heterogeneity, and consequently facilitate more precise research questions to be posed and examined (e.g., Strauss & Smith, 2009). Additionally, as the determination of when a construct is sufficiently elemental requires theoretical justification, the chapter also emphasised the value of qualitative research and extant literature, rather than generating statistical evidence, for informing the conceptualisation of constructs (e.g., Podsakoff et al., 2016; Smith et al., 2009).

As mentioned in relation to the aims of this thesis, there are several limitations to previous research investigating physical activity self-monitoring in relation to eating psychopathology and compulsive exercise. With regard to construct conceptualisation, these previous studies have tended to focus narrowly on the use of fitness trackers, which vary considerably in terms of their functionality (e.g., Lyons

et al., 2014). As such, by investigating physical activity self-monitoring more broadly, the insights generated through this thesis identified elemental aspects of fitness tracker use, and other forms of monitoring. Furthermore, by conducting this research in samples that included people with high levels of eating psychopathology and compulsive exercise, the insights are likely to include aspects of physical activity self-monitoring that are particularly important to consider in this population. Consequently, having supported and emphasised the heterogeneity encompassed by physical activity self-monitoring, a general implication of this thesis is that assessments of only fitness tracker use (e.g., Simpson & Mazzeo, 2017) might limit the contribution a study can make to the field. This implication applies to studies using different research methodologies, such as ensuring to assess different aspects of physical activity self-monitoring using separate self-report items, or manipulating one aspect while controlling for others in experimental research.

A particularly clear illustration of the need for elemental conceptualisations in this context regards the specific focus of physical activity self-monitoring. Specifically, the findings of this thesis support a distinction between the monitoring of the energy expended through physical activity, and non-physiological aspects of physical activity (e.g., distance, duration). While energy-expenditure and non-physiological aspects might similarly facilitate an awareness of one's physical activity, energy-expenditure is indicated to play a specific role in comparisons to one's energy-intake. Consequently, as non-physiological aspects are arguably less directly related to one's energy-intake, grouping these aspects with energy-expenditure when assessing physical activity self-monitoring might underestimate a relationship with one's energy-intake. Instead, by assessing statistical relationships separately for the monitoring of each focus, more precise hypotheses can be tested. For instance, whether monitoring the energy expended from physical activity is more strongly related to eating psychopathology than monitoring non-physiological aspects of physical activity.

While more specific future directions for research are proposed in a following section (10.5.), the findings have further general implications. A first general implication is that, as highlighted above, the findings emphasise the importance of considering the

content of measurement instruments. This issue was most clearly demonstrated in the review of body checking scales (Study 1). Specifically, two reviews of body checking studies (Nikodijevic et al., 2018; Walker et al., 2018) included studies that varied greatly in terms of whether they predominantly assessed the self-monitoring of one's physique, comparisons to physique-related reference values, or cognitions concerning body checking. Of greater concern, one review included a study that was unrelated to body checking (but nominally appeared to be). As such, this inclusion was a clear illustration of the reviewers neglecting the content of the assessment of, what was considered to be, 'body checking'. As such, the findings of this review highlighted, or at least offered a reminder, that it is vital to consider the content of a measurement instrument when designing a study, or including one in a review. Indeed, this consideration was neglected in the initial stages of planning this thesis, as the body checking questionnaire (Reas et al., 2002) was selected for the survey (Study 4) as a measure of physique self-monitoring. However, following greater consideration of content validity, it became apparent that the content of this instrument was insufficiently precise for the purposes of this thesis.

Another general implication is that, having used eating disorder-related social media data in two studies (Studies 3 and 7) to gain qualitative insights into physical activity self-monitoring, this thesis indicates the value of using these data for the purpose of construct conceptualisation. Indeed, while studies based on eating disorder-related social media data tend to focus on the structure of online communities (e.g., Wang et al., 2018), few studies have used these data to conceptualise a construct. Two exceptions are studies that have used eating disorder-related online content to investigate the concept of recovery (Bohrer, Foye, & Jewell, 2020; Keski-Rahkonen & Tozzi, 2005), with the study by Bohrer and colleagues being based on the methodology utilised in one of the qualitative studies reported in this thesis (Study 3). As novel insights were generated by both qualitative studies based on eating disorder-related online content reported in this thesis, the value of using these data for construct conceptualisation is supported.

10.3.2. Prevention and intervention

Within Honary and colleagues' study (2019), a clinician reported that they discouraged the use of fitness trackers by their patients with eating disorders. Relatedly, the study reported in this thesis that investigated engagement with *MyFitnessPal* (Study 3) indicated that the app limits its functionality in people suspected as having an eating disorder. As such, there are clear attempts in both clinical practice and the development of products to intervene when the use of fitness trackers could be problematic. However, the commenters in the study concerning *MyFitnessPal* tended to view these interventions negatively, such as describing them as 'punitive'. Furthermore, the interventions implemented by the app were reported to be easily circumvented, which suggests that the ways in which problematic use is currently addressed is relatively ineffective. Consequently, it is important to develop more effective ways in which to address the problematic use of fitness trackers, as well as the performance of physical activity self-monitoring more broadly. This importance of developing more effective interventions applies to both manufacturers of fitness trackers, and to clinicians working with eating disorder patients.

One of the main challenges for interventions in this area is the existing awareness of one's physical activity (i.e., awareness at the time of intervention). As observed in the interviews with people with a high level of compulsive exercise (Study 5), when aware of their physical activity, interviewees reported monitoring less frequently, or more approximately. Consequently, limiting the physical activity self-monitoring of someone who has a high level of awareness of their physical activity is, arguably, unlikely to have a large effect. Another challenge for intervention is that individuals potentially experience greater anxiety if they are unable to monitor their physical activity (Study 6). Such an increase in anxiety could potentially lead to an individual enacting a different behaviour to control their anxiety. One possible behaviour that could serve this function is physical activity, as exercise being used to reduce anxiety is characteristic of compulsive exercise (e.g., Taranis et al., 2011). As such, a potential increase in anxiety resulting from not monitoring one's physical activity could speculatively lead to a greater level of exercise, as a higher level of exercise might be

required to offset the additional anxiety arising from the lack of monitoring. A last challenge for intervention is that, if restricting only one form of physical activity self-monitoring (e.g., fitness trackers), a person might simply use a different form. Speculatively, this might influence the type of exercise one engages in so that it can be monitored (e.g., mentally counting sit-ups if unable to use a fitness tracker to monitor a run). Alternative forms of monitoring are of particular importance in relation to fitness trackers, as, due to the ubiquity of these technologies, one could simply use a similar app or device, if prevented from using another.

While it is easy to consider the challenges to addressing the problematic use of physical activity self-monitoring, it is, perhaps, more difficult to suggest ways in which such monitoring could be prevented or addressed. In terms of self-monitoring physical activity, prompting or encouraging a person to attend to specific focuses in relation to their physical activity might represent a beneficial point for intervention. Such a suggestion is comparable to the monitoring of one's diet proposed in CBT-E (Fairburn et al., 2003), which advocates the monitoring of meals, but not calorie-intake. As reported in this thesis and previous research (e.g., Bratland-Sanda et al., 2010), people with high levels of eating psychopathology might tend not to monitor or record physical activity that does not 'count' as exercise (e.g., walking). As such, prompting or encouraging the monitoring of all physical activity (i.e., including light exercise) might help address the underestimation of physical activity by drawing attention to what the person is actually doing. Similarly, prompting the consideration of the energy expended through one's physical activity *and* basal metabolic rate could help to address the underestimation of overall energy-expenditure.

Although encouraging the monitoring of all physical activity (or energy-expenditure) might help address the underestimation that appears characteristic of people with high levels of eating psychopathology, such a strategy is potentially risky. Specifically, by encouraging people to monitor more, it is possible that such an intervention would increase the importance placed on the quantity of one's physical activity or energy-expenditure, which could increase one's level of eating psychopathology or compulsive exercise. Instead, a less risky strategy might be to prompt the monitoring of other focuses related to physical activity. For example, a novel finding of the final

study (Study 7), is that a commenter indicating a high recovery-focus reported focusing on aspects of the environment (e.g., sounds, smells) during physical activity, rather than aspects of the activity itself (e.g., speed, distance). As such, for instance, fitness trackers could potentially reward the monitoring or recording of such environmental aspects, which might help to promote a more rounded view of one's physical activity, and proportionally dilute the focus on the quantity of the activity. Similarly, in line with impaired interoceptive awareness being characteristic of eating disorders (e.g., Pennesi & Wade, 2016), rewarding the monitoring of physical sensations (e.g., aches, pain) might also be beneficial, particularly given the tendency to exercise despite injury, illness or pain (Noetel et al., 2017).

Other possible intervention strategies arise from the findings of the interviews (Study 5), and concern self-monitoring in relation to the reference values against which one's physical activity is compared. For example, comparisons based on specific aspects of physical activity might be more beneficial than others, such as focusing on the time spent being physically active compared to doing other activities. Such a comparison could raise awareness of the impact of excessive physical activity, and lead to a revision of one's goals. This potential specific role of focusing on the time spent being physically active further supports the need for elemental constructs (i.e., considering duration separately from, for example, speed and distance). Comparing one's physical activity to what an average person does, might also facilitate the identification of excessive physical activity. In terms of reference values more generally, instead of discouraging self-monitoring, framing the target amount of physical activity as a maximum, rather than a minimum target to reach, could be beneficial. By still allowing physical activity self-monitoring, a person might not experience the anxiety that potentially results from not monitoring, and is provided with a clearer target not to exceed. Such an approach is comparable to the setting of a minimum amount of calorie-intake to achieve – i.e., meal planning and mechanical eating (cf. cognitive behaviour therapy multi-step; Grave, 2005). Last, two other studies in this thesis (Studies 3 and 7) reported that the evaluation of discrepancies between one's current and target physical activity was based on very small differences. As this can be seen as a dichotomous evaluation, which is characteristic

of perfectionism (Shafran et al., 2002), therapeutic interventions that encourage less 'black or white' thinking might be particularly effective.

Overall, the potential strategies for prevention and intervention highlighted above predominantly concern the focuses of one's physical activity self-monitoring. However, as the form of self-monitoring might influence the focus to which one attends (e.g., Dombrowski et al., 2016), encouraging the use of a form that supports the monitoring of potentially 'safer' aspects of physical activity (e.g., environmental aspects) might be particularly effective. Indeed, attempts to change one's form of physical activity self-monitoring, rather than prevent it completely might be more acceptable to people trying to reduce their levels of eating psychopathology and compulsive exercise.

As mentioned above, fitness trackers could introduce functionality that potentially reduces the detrimental effects of these technologies (e.g., encouraging monitoring environmental aspects during physical activity, or comparing time spent exercising to that spent doing other activities). Such functionality could also be added to apps designed for eating disorder recovery (e.g., Recovery Record; e.g., Lindgreen et al., 2018). Furthermore, fitness trackers could be modified to include functionality that assesses the user's patterns of engagement with the app or device, and intervenes when a user's usage is deemed problematic. For example, as suggested by one of the experts in Honary and colleagues' study (2019), fitness trackers could track and limit the length of time that an individual can use the technology, although this could potentially be viewed negatively.

While several implications for prevention and intervention were outlined in this subsection, these should be considered as speculations about ways in which problematic physical activity self-monitoring could be addressed. The reason for this consideration is that the research findings presented in this thesis provide substantive evidence for the physical activity self-monitoring construct, and are therefore hypothesis-generating rather than hypothesis-testing. Therefore, while these suggested approaches might ultimately be beneficial for prevention and intervention concerning eating psychopathology and compulsive exercise, they should not be implemented without further research to evaluate their effectiveness.

This issue is discussed further in the following section concerning future research directions (section 10.5.).

10.3.3. Online communities

The findings of this thesis, particularly the study investigating patterns of commenting (Study 6), also have implications for online eating disorder forums. First, by identifying the other forums with which users of eating disorder forums engage, the findings highlight forums that could be approached to promote interventions in the case that eating disorder communities are not willing to do so. Second, by characterising the commenters on eating disorder forums in terms of their particular interests (i.e., the topics of forums they comment on), more personalised intervention strategies could be developed, which might improve adherence to these programmes (e.g., Beatty & Binnion, 2016). Last, a particularly concerning finding in this thesis was the indication that people engage with thinspiration for pornographic reasons. As such, a major implication is the need to ensure that people in vulnerable positions, such as those contributing thinspiration content (e.g., images), are both aware of who might be viewing this, and protected from any potential coercion or exploitation.

10.4. Limitations

While the limitations of each study were discussed in their respective chapters, it is important to consider more general limitations of the research comprising this thesis. These limitations relate broadly to the sampling of data (subsection 10.4.1.), the exploratory nature of the research (subsection 10.4.2.), and potentially confirmatory biases of the researcher (subsection 10.4.2.).

10.4.1. Data sampling

Throughout the studies comprising this thesis, a limitation was that the experiences of eating disorder diagnoses and treatment reported by participants were not clinically verified. While conducting additional research within a sample of patients with eating disorders would have addressed this issue, it is unlikely that additional

aspects of physical activity self-monitoring specific to these patients would have been captured. A reason for further insights being unlikely in this population is due to 93 survey respondents (Study 4) reporting that they were currently receiving treatment for an eating disorder, with a further 289 indicating that they had previously received such treatment. As such, although some of these cases might not have been clinically significant (e.g., a person diagnoses themselves and visits a private practitioner), it is unlikely that all participants who reported having received treatment for an eating disorder would not have met clinical criteria. An additional reason for further insights being unlikely is the use of online content from over 8,000 commenters on eating disorder subreddits. Similarly, while not all of the commenters might have had a clinically significant experience of an eating disorder, due to the large sample size, the overall comments could have, at least partly, reflected the experiences of current or previous patients, even if not clinically verified.

A limitation of using data from *Reddit* was that the demographics of its users might differ from other social media platforms (e.g., *Facebook*, *Twitter*, *Instagram*). For example, a higher percentage of women than men from the United States of America have been indicated to use *Facebook* (75% women, 63% men) and *Instagram* (43% women, 31% man), while the opposite was found for *Reddit* (15% men, 8% women) and *Twitter* (24% men, 21% women; Pew Research Center, 2020). As such, the findings reported in this thesis that were generated from *Reddit* should not be compared uncritically to findings generated from other social media platforms. Regarding the sampling of subreddit comments, a further limitation was that the text-mining approach was reliant on identifying exact terms (Studies 2, 3 and 7). As such, it is possible that content related to physical activity self-monitoring was not identified if commenters used terminology that was not captured within the search terms. However, the effect of this limitation was mitigated by consulting multiple sources when developing lists of search terms (e.g., app stores, responses from survey participants) to ensure that they were as comprehensive as possible.

10.4.2. Exploratory research

Reflecting the aims of this thesis, the studies reported in the previous chapters were exploratory in nature in order to generate evidence for substantive validity, which is

typically neglected in comparison to structural and external validity (cf. Flake et al., 2017). Furthermore, in line with the dimensional approach to construct validation advocated in RDoC (Cuthbert & Kozak, 2013), the research generated substantive evidence for the breadth of physical activity self-monitoring (i.e., its entire normal to abnormal range), rather than focusing only on aspects present within a clinical population. As a result, this thesis achieved its aims of identifying aspects of physical activity self-monitoring to consider in relation to eating psychopathology and compulsive exercise. However, by generating insights relating to a normal to abnormal range (e.g., from people with low to high levels of eating psychopathology), it is not possible to conclude whether an identified aspect of physical activity self-monitoring is characteristic of one of the extremes of eating psychopathology, or whether it would be observed in people with varying levels of eating psychopathology or compulsive exercise. For example, although the underestimation of physical activity was indicated in comments made on eating disorder subreddits (i.e., whose commenters, on average, indicate high levels of eating psychopathology; e.g., Peebles et al., 2012), it is possible that such underestimation is also performed by people with low levels of eating psychopathology or compulsive exercise. As such, while the implications can inform clinicians and researchers about the aspects of physical activity self-monitoring that require consideration in relation to eating psychopathology and compulsive exercise, it is not possible to conclude which aspects require the most attention. To identify the most important aspects of physical activity self-monitoring, the relationship between the different aspects, and eating psychopathology and compulsive exercise would require testing. The ways in which future research could address this issue are outlined in the next section.

10.4.3. Confirmatory bias

For all qualitative analyses reported in this thesis, a 'critical friends' approach was adopted to encourage reflexivity in the researcher's interpretation of the findings (Cowan & Taylor, 2016; Smith & McGannon, 2017; Smith & Sparkes, 2006). While this approach was taken to assist the researcher in considering alternative interpretations of the data, a confirmation bias might still have affected the findings presented within this thesis. For example, through the interviews conducted with

people with high levels of compulsive exercise (Study 5), the theme *Physical activity comparisons* was generated, and included the subtheme *Physical activity reference values*. The subtheme *Physical activity reference values* was interpreted as reflecting a previous distinction made by Harkin and colleagues (2016), specifically, that comparisons are made to other people, the past or ideal targets. However, while the data were interpreted as supporting this distinction, it is possible that the researcher's interpretation was influenced by the distinction and, therefore, biased towards it. As mentioned, although a critical friends approach aimed to minimise such an effect of the researcher's confirmation bias, this bias might still have had an influence on the interpretation of findings in this thesis.

10.5. Future research directions

As discussed, the findings of this thesis have several implications for research, prevention and intervention, and online communities. In light of these implications, future research is clearly warranted, with particularly clear directions relating broadly to: the validation and measurement of 'pathological physical activity self-monitoring' (subsection 10.5.1.); and factors influencing the potential relationships between aspects of pathological physical activity self-monitoring, and eating psychopathology and compulsive exercise (subsection 10.5.2.).

10.5.1. Validating and measuring pathological physical activity self-monitoring

The research comprising this thesis generated comprehensive substantive evidence for the physical activity self-monitoring construct in people with high levels of eating psychopathology and compulsive exercise. While substantive validity evidence is crucial for robustly conceptualising a construct, it is not able to indicate the relative importance of each identified aspect. As such, rather than suggesting that the aspects of physical activity self-monitoring identified in the studies were necessarily pathological, deliberate reference was made throughout this thesis to investigating the construct 'in relation to eating psychopathology and compulsive exercise'. In

order to assess which of the identified aspects of physical activity self-monitoring can be viewed as pathological (i.e., related to eating psychopathology and/or compulsive exercise), a valid measurement instrument for the construct is required. As emphasised in RDoC (Cuthbert & Kozak, 2013), measurement instruments are required that relate to different units of measurement, such as behaviours, physiology and genes. However, this section will focus on future research required to develop and validate a self-report instrument.

A valid self-report scale for pathological physical activity self-monitoring would require the generation of structural and external validity evidence (cf. Flake et al., 2017). However, in order to generate these types of evidence, a set of self-report items that are relevant and representative of the construct are first required. When creating these items, the stems, response options and instructions all require careful consideration, and the initial item-set should be over-inclusive (Clark & Watson, 2019). In other words, items should be developed that assess content outside one's theoretical view of a construct, and that will likely not be included in the final item-pool (i.e., after structural and external validity testing). Reflecting the need to be over-inclusive at this stage, comprehensive research that captures the breadth of a construct is of great importance. As such, the series of studies presented in this thesis enable the creation of such an over-inclusive item-set for pathological physical activity self-monitoring. Indeed, based on the findings presented in this thesis, several aspects of pathological physical activity self-monitoring should be represented in an initial item-set for this construct, including: forms (e.g., instrumental, or mental and sense-based self-monitoring); focuses (e.g., energy-expenditure, or non-physiological aspects of physical activity); engagement (e.g., frequency or consistency); accuracy (e.g., underestimation of physical activity); and awareness. Examples of possible self-report items relating to these aspects are presented in Table 17.

Table 17. Example pathological physical activity self-monitoring self-report items

Aspect of physical activity self-monitoring	*Example self-report item*
Form	I monitor my physical activity using an app or device
Focus	I monitor the time I spend being physically active
Engagement	I monitor my physical activity every time I exercise
Accuracy	I deliberately underestimate my physical activity
Awareness	I am aware of my level of physical activity

Once an over-inclusive item-set has been developed, and reviewed by experts and the population of interest (e.g., Gehlbach & Brinkworth, 2011), structural and external validity evidence can be generated for the item-set. As stated, the substantive evidence generated in this thesis is unable to indicate the relative importance of an aspect of physical activity self-monitoring to eating psychopathology and compulsive exercise. However, evidence regarding an item or item-set's external validity would address this limitation. For example, the strength of the relationship between an item or item-set's score, and the score on a measure of eating psychopathology or compulsive exercise could be estimated (cf., predictive validity; e.g, Flake et al., 2017). Similarly, by comparing an item or item-set's score between groups with high or low levels of eating psychopathology or compulsive exercise, the extent to which the content is characteristic of a specific group could be assessed (i.e., known groups; e.g., Flake et al., 2017). As a result, these approaches to generating external validity evidence would be able to determine which aspects of physical activity self-monitoring should be considered 'pathological', and which should not.

10.5.2. Factors influencing the relationship between pathological physical activity self-monitoring, and eating psychopathology and compulsive exercise

As well as identifying potentially important aspects of pathological physical activity self-monitoring, the findings of this thesis also highlight factors that might influence

(e.g., moderate, mediate) the relationship between the construct, and eating psychopathology and compulsive exercise. For example, as suggested by findings reported in this thesis, physical activity self-monitoring can be conceptualised as a safety-seeking behaviour, which is used to increase one's sense of control, and decrease anxiety (cf. Salkovsis, 1991). Due to anxiety being argued to play a crucial role in eating disorders (e.g., Pallister & Waller, 2008), the extent of a person's anxiety surrounding their physical activity might influence the impact that self-monitoring this behaviour has on eating psychopathology and compulsive exercise. Another example concerns the reference value to which someone compares their current physical activity, which might also impact the relationship with eating psychopathology and compulsive exercise. Specifically, comparison of one's physical activity energy-expenditure to a target informed by one's desired energy deficit appears to be a particularly important aspect to investigate in future research. A last example is one's degree of focus on eating disorder recovery, which was consistently suggested to influence physical activity self-monitoring (Studies 2, 3, 4 and 7; Eikey & Reddy, 2017; Honary et al., 2019).

10.5.3. Summary

Overall, the research presented in this thesis is invaluable for highlighting aspects of physical activity self-monitoring that require consideration in relation to eating psychopathology and compulsive exercise. Additionally, other factors that might influence a relationship between pathological physical activity self-monitoring, and eating psychopathology and compulsive exercise are indicated. A general future avenue of research is to conduct experimental and longitudinal studies that can elucidate the causal relationship between these factors. Indeed, due to self-monitoring forming part of a feedback loop in control theory (Carver & Scheier, 1982), identifying causal relationships within this loop could represent potential intervention targets. For example, if monitoring energy-expenditure was found to cause greater anxiety than monitoring non-physiological aspects of physical activity (e.g., distance), interventions that promote the monitoring of non-physiological aspects might assist in interrupting a pathological feedback loop. However, while research into causal relationships is important, the development of a valid

measurement instrument for pathological physical activity self-monitoring is a vital first step.

10.6. Conclusion

Through using a variety of data sources (e.g., a large online survey, interviews, social media data), the studies reported in this thesis generated comprehensive insights that inform the conceptualisation of the physical activity self-monitoring construct in relation to eating psychopathology and compulsive exercise. The findings relate to aspects of physical activity self-monitoring that are potentially pathological (e.g., patterns of engagement, accuracy of the monitoring), as well as a variety of other factors that might influence a relationship between the construct, and eating psychopathology and compulsive exercise (e.g., comparisons to reference values, monitoring non-physical activity-related focuses, psychosocial factors). As these studies aimed to generate substantive validity evidence, the findings represent the crucial first step in developing a valid measurement instrument of pathological physical activity self-monitoring. Despite such a measure being necessary to evaluate the extent to which the different aspects of physical activity self-monitoring are pathological, the findings reported in this thesis have several immediate implications. First, the insights can assist clinicians in eating disorder clinics to consider the ways in which their patients might self-monitor physical activity, and how this might influence their symptoms. Second, having identified ways in which people circumvent interventions in fitness trackers that ostensibly target problematic use, developers of these technologies might be able to utilise the insights generated in this thesis to design more effective ways to intervene. Last, while aspects of physical activity self-monitoring that are pathological cannot currently be specified, the findings of this thesis highlight the breadth and complexity of this construct. For research in the area of eating psychopathology and compulsive exercise, this breadth and complexity is a crucial consideration, as the conceptualisation of physical activity self-monitoring tends to concern the use of fitness trackers. As such a narrow conceptualisation risks neglecting potentially pathological aspects of physical activity

self-monitoring, this thesis strongly supports and advocates for the consideration of the broader construct in the future.

11. References

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12. Appendices

Appendix A: Behaviours and Cognitions coding framework

This coding framework was developed to identify the behaviours and cognitions assessed by each body checking item. Two raters should apply this framework separately, and each rater should select and record the code in the following framework that best represents the construct assessed by each body checking item. As such, only *one* code is applied to each item. Following the calculation of the degree of interrater agreement (Cohen's kappa coefficient), any discrepancies between the two raters' codes should be resolved through discussion.

Code	*Description of code*
A	*Self-monitoring technique only* Select this code if the item assesses: • The performance of a self-monitoring technique (i.e., perceiving and/or recording one's current state) without comparing one's current state to a reference value • A self-monitoring technique that is undertaken by the same person whose current state is being monitored
B	*Comparison of one's current state to a past state* Select this code if the item assesses: • The performance of a comparison of one's current state to a previous state • A past state might be explicitly stated (e.g., "one month ago") or implicit (e.g., "I can still do something", with 'still' implying a comparison to the past)
C	*Comparison of one's current state to other people's state* Select this code if the item assesses: • The performance of a comparison of one's current state to other people

	• 'Other people' includes specific people (e.g., friends, celebrities) or abstract representations of other people (e.g., "what a normal person would do")
D	*Comparison of one's current state to a desired (future) state* Select this code if the item assesses: • The performance of a comparison of one's current state to a desired target (i.e., target, goal)
E	*Elicit feedback from other people about one's current or previous state* Select this code if the item assesses: • The elicitation of feedback from others about one's current state
F	*Cognition related to one's current or previous state* Select this code if the item assesses: • A cognition (e.g., motivation, thought, concern, perceived importance) related to one's current or previous state
G	*Monitoring focus other than one's current state* Select this code if the item assesses: • The performance of a monitoring technique that does not provide information on one's current state

Appendix B: Body-Related Focuses coding framework

This coding framework was developed to identify the body-related focuses assessed by each body checking item. This coding framework should be applied *after* the *Behaviours and Cognitions* framework (Appendix A), and should only be applied to items given a code in the preceding framework relating to the performance of a self-monitoring technique or comparison (i.e., *A*, *B*, *C* or *D*). Two raters should apply this framework separately, and each rater should select and record the codes in the following framework that represent the construct(s) assessed by each body checking item. As such, *all* relevant codes are applied to each item, and, therefore, the degree of interrater agreement is not calculated. Any discrepancies between the two raters' codes should be resolved through discussion.

The codes relate to different aspects of the body (e.g., body parts, body composition, appearance). A code should only be selected if the aspect of the body is the *focus* of a self-monitoring technique or comparison. For example, if a body part is used for the purpose of self-monitoring and is not the focus of self-monitoring, this body part should not be coded (e.g., "using one's fingers to measure the size of one's wrist", 'wrist' would be coded but 'fingers' would not).

Code	*Description of code*
0	Not explicitly body-related
101	Body part: General (Body part not further specified)
102	Body part: Head/Face (excluding Neck)
103	Body part: Neck/Collarbone (excluding Head, Chest and Shoulders)
104	Body part: Shoulders (excluding Neck, Chest and Arms)
105	Body part: Chest
106	Body part: Abdomen/Stomach
107	Body part: Back
108	Body part: Hips
109	Body part: Bottom
110	Body part: Legs/Thighs (excluding Hips, Bottom, Ankles and Feet)

111	Body part: Ankles/Feet (excluding Legs)
112	Body part: Arms (excluding Wrists and Shoulders)
113	Body part: Wrists (excluding Arms and Hands)
114	Body part: Hands (excluding Wrists)
201	Body composition: Size/Shape
202	Body composition: Weight/Mass
203	Body composition: Fat
204	Body composition: Muscle
205	Body composition: Leanness
206	Body composition: Bones
207	Body composition: Joints
208	Body composition: Skin
301	Appearance

Appendix C: Body checking instruments in studies

Study				*Body checking instrument included in review(s)*		
ID	*Reference*	*Included in Walker et al. (2018)?*	*Included in Nikodijevic et al. (2018)?*	*Instrument*	*Alterations to original items*	*Final item-set reference*
1	Alperin, Hornsey, Hayward, Diedrichs, and Barlow (2014)	No	Yes	BCQ	Added 5 items "to be gender-inclusive regarding checking for muscularity" (p40)	BCQ(+5)
2	Amin, Strauss, and Waller (2014)	Yes	Yes	BRBS: Checking subscale	-	BRBS:Checking
3	Bailey and Waller (2017)	No	Yes	BCQ	-	BCQ
4	Bamford, Attoe, Mountford, Morgan, and Sly (2014)	No	Yes	BCQ	-	BCQ
5	Blechert, Nickert, Caffier, and Tuschen-Caffier (2009)	No	Yes	BCQ	-	BCQ
6	Blechert, Ansorge, and Tuschen-Caffier (2010)	No	Yes	BCQ	-	BCQ
7	Breithaupt, Payne, and Rose (2014)	Yes	Yes	BCQ	-	BCQ

8	Calogero (2009)	Yes	No	OBCS: Body surveillance subscale	-	OBCS:BS
9	Calogero and Pina (2011)	Yes	No	OBCS: Body surveillance subscale	-	OBCS:BS
10	Calugi, Dalle Grave, Ghisi, and Sanavio (2006)	Yes	Yes	BCQ	-	BCQ
11	Calugi, El Ghoch, and Dalle Grave (2017)	Yes	Yes	BCQ	-	BCQ
12	Dakanalis, Favagrossa, et al. (2015)	Yes	Yes	MBCQ	-	MBCQ
13	Dakanalis, Carra, et al. (2015)	No	Yes	BCQ	-	BCQ
14	Daniel and Bridges (2010)	Yes	No	OBCS: Body surveillance subscale	-	OBCS:BS
15	De Berardis et al. (2007)	No	Yes	BCQ	-	BCQ
16	Engeln-Maddox, Miller, and Doyle (2011)	Yes	No	OBCS: Body surveillance subscale	-	OBCS:BS
17	Fitzsimmons-Craft et al. (2012)	Yes	No	OBCS: Body surveillance subscale	Excluded 1 comparison-related item (*I rarely compare how I look with how other people look*) to "minimize issues related to construct overlap" (p45)	OBCS:BS(-1)

18	Grilo et al. (2005)	Yes	No	BSQ	Included item 30 (*Have you pinched areas of your body to see how much fat there is?*)	BSQ:Item30
19	Haase, Mountford, and Waller (2007)	Yes	No	BCQ	-	BCQ
20	Hildebrandt, Walker, Alfano, Delinsky, and Bannon (2010)	No	Yes	MBCQ*	-	MBCQ
21	Jansen et al. (2016)	No	Yes	BCQ	-	BCQ
22	Kachani, Brasiliano, Cordas, and Hochgraf (2013)	No	Yes	BCCS	-	BCCS
23	Kachani, Barroso, Brasiliano, Hochgraf, and Cordas (2014)	No	Yes	BCAQ(2004)	-	BCAQ(2004)
24	Kraus, Lindenberg, Zeeck, Kosfelder, and Vocks (2015)	No	Yes	BCQ	-	BCQ
25	Latner (2008)	Yes	No	BSQ	Included item 30 (*Have you pinched areas of your body to see how much fat there is?*)	BSQ:Item30
26	Latner, Mond, Vallance, Gleaves, and Buckett (2012)	Yes	Yes	BCQ	-	BCQ

27	Lavender et al. (2013)	Yes	No	BC-EMA	Included two items (*I made sure my thighs didn't touch* and *I checked my joints and bones for fat*)	BC-EMA
28	Legenbauer et al. (2017)	Yes	Yes	BCAQ(2017): Checking subscale[*,**]	-	BCAQ(2017):Checking
29	Lewer, Nasrawi, Schroeder, and Vocks (2016)	Yes	Yes	BCQ	-	BCQ
30	Linardon and Mitchell (2017)	Yes	No	BCQ	-	BCQ
31	Luethcke, McDaniel, and Becker (2011)	No	Yes	BCQ	-	BCQ
32	MacDonald, McFarlane, and Olmsted (2014)	No	Yes	BCQ	-	BCQ
33	Mercurio and Rima (2011)	Yes	No	OBCS: Body surveillance subscale	-	OBCS:BS
34	Meyer, McPartlan, Rawlinson, Bunting, and Waller (2011)	Yes	Yes	BRBS: Checking subscale[*]	-	BRBS:Checking
35	Morgan, Lazarova, Schelhase, and Saeidi (2014)	No	Yes	BCQ	-	BCQ
36	Mountford, Haase, and Waller (2007)	Yes	Yes	BCQ	-	BCQ

37	Mountford, Haase, and Waller (2006)	No	Yes	BCQ	-	BCQ
38	Mountford et al. (2015)	No	Yes	BCQ	-	BCQ
39	Overas, Kapstad, Brunborg, Landro, and Lask (2015)	No	Yes	BCQ	-	BCQ
40	Pellizzer, Tiggemann, Waller, and Wade (2018)	Yes	Yes	BCQ	-	BCQ
41	Reas, Whisenhunt, Netemeyer, and Williamson (2002)	No	Yes	BCQ*	-	BCQ
42	Reas, Grilo, Masheb, and Wilson (2005)	Yes	No	BSQ	Included item 30 (*Have you pinched areas of your body to see how much fat there is?*)	BSQ:Item30
43	Reas, White, and Grilo (2006)	Yes	Yes	BCQ	-	BCQ
44	Shafran, Fairburn, Robinson, and Lask (2004)	No	Yes	BCAQ(2004)*	-	BCAQ(2004)
45	Shafran and Robinson (2004)	No	Yes	BCAQ(2004)	-	BCAQ(2004)
46	Spangler (2010)	Yes	No	BCQ	-	BCQ

47	Trottier, MacDonald, McFarlane, Carter, and Olmsted (2015)	No	Yes	BCQ	-	BCQ
48	Vartanian and Grisham (2011)	No	Yes	BCQ	-	BCQ
49	Vocks, Stahn, Loenser, and Legenbauer (2009)	No	Yes	BCQ	-	BCQ
50	Waller, Sines, Meyer, and Mountford (2008)	No	Yes	BCQ	-	BCQ
51	Walker, Anderson, and Hildebrandt (2009)	No	Yes	MBCQ	-	MBCQ
52	Waller and Marcoulides (2013)	Yes	No	BSBS: Checking subscale	-	BSBS:Checking
53	White and Warren (2013)	No	Yes	BCQ	-	BCQ
54	White, Claudat, Jones, Barchard, and Warren (2015)	No	Yes	BCQ	-	BCQ

BCAQ(2004) = Body Checking and Avoidance Questionnaire (Shafran et al., 2004)
BCAQ(2017) = Body Checking and Avoidance Questionnaire (Legenbauer et al., 2017)
BCCS = Body Checking Cognitions Scale (Mountford et al., 2006)
BC-EMA = Body Checking Ecological Momentary Assessment (Engel et al., 2005)
BCQ = Body Checking Questionnaire (Reas et al., 2002)
BRBS = Body-Related Behaviours Scale (Meyer et al., 2011)

BSBS = Brief Safety Behaviours Scale (Bohn, Brown, Farquharson, & Tata, 2009)
BSQ = Body Shape Questionnaire (Cooper, Taylor, Cooper, & Fairburn, 1987)
MBCQ = Male-Specific Body Checking Questionnaire (Hildebrandt et al., 2010)
OBCS = Objectified Body Consciousness Scale (McKinley & Hyde, 1996)

*Study in which body checking measurement originally developed
**Misreported as BCQ in Nikodijevic et al. (2018)

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Appendix D: Text-mining search terms

Recovery terms				
recovery	recover	recovers	recovered	recovering
*Eating terms**				
food	eaten	cals	calorific	binging
foods	calorie	kcals	binge	diet
eat	calories	kilocalorie	binges	diets
eats	cal	kilocalories	binged	dieted
ate	kcal	caloric	bingeing	dieting
Body terms				
stomach	weigh	weighed	body	fat
shape	weighs	weighing	bodies	fatness
weight				
Exercise terms				
activity	sports	dug	carries	walking
activities	lift	digging	carried	run
exercise	lifts	cycle	carrying	runs
exercises	lifted	cycles	tennis	ran
exercised	lifting	cycled	walk	running
exercising	dig	cycling	walks	
sport	digs	carry	walked	

Fitness tracker terms			
activityapp	forerunner	misfitphase	runtasticroad
activityband	fossilq	misfitray	runtasticrunning
activitybracelet	garmin	misfitshine	samsunggear
activitymonitor	garminfenix	moov	smartband
activitytracker	garminforerunner	moovhr	sonysmartband
activitywatch	garminvivoactive	moovnow	sonysmartwatch
adidasmicoach	garminvivofit	movesapp	stepcounter
alta	garminvivoki	myfitness	stepmonitor
applehealth	garminvivomove	myfitnesspal	steptracker
applewatch	garminvivosmart	mykronoz	strava
bellabeat	gymappworkout	mykronozzebracelet	striiv
bellabeatleaf	healbe	mykronozzecircle	striivfusion
bellabeatleaves	healbegobe	mykronozzefit	striivsmart
caloriecounter	heartratemonitor**	mykronozzeround	swatchtouch
caloriemonitor	huaweiband	mykronozzesport	sweatcoin
calorietracker	huaweifit	mykronozzetime	talkband
casioomnisync	huaweitalkband	mykronozzewatch	tickr
charitymiles	huaweiwatch	nikerun	tomtom
couchk	ihealth	niketraining	tomtommulti
cronometer	ihealthedge	nokiago	tomtomspark
dailyworkouts	jawbone	nokiasteel	tomtomtouch
endomondo	jawboneup	pebble	virginpulse

epsonpulsense	lglifeband	pebbleclassic	vivoactive
fitbit	lumolift	pebblesteel	vivofit
fitbitalta	madbarz	pebbletime	vivoki
fitbitaria	mapmyfitness	pedometer	vivomove
fitbitblaze	mapmyhike	pedometry	vivosmart
fitbitcharge	mapmyride	polar	wahoo
fitbitflex	mapmyrun	polara	wahootickr
fitbitionic	mapmywalk	polarh	wellograph
fitbitone	merlinactifit	polarloop	wodbook
fitbitsurge	mfp	polarm	workoutlog
fitbitzip	microsoftband	polarv	xiaomimi
fitnessapp	mio	pumpup	zebracelet
fitnessband	mioalpha	ridegps	zecircle
fitnessbracelet	miofuse	runkeeper	zefit
fitnessbuddy	miolink	runtastic	zeround
fitnessbuddies	mioslice	runtasticgps	zesport
fitnessmonitor	mirabracelet	runtasticheart	zetime
fitnesspal	misfit	runtasticmoment	zewatch
fitnesspoint	misfitcommand	runtasticmountain	
fitnesstracker	misfitflare	runtasticorbit	
fitnesswatch	misfitflash	runtasticpro	
MyFitnessPal terms			
mfp	myfitness	mfps	myfitnesss
myfitnesspal	fitnesspal	myfitnesspals	fitnesspals
Fitbit terms			
fitbit	fitbitaria	fitbitalta	fitbitsurges
fitbitcharge	fitbitflex	fitbitzip	fitbitblazes
fitbits	fitbitsurge	fitbitionic	fitbitflexes
fitbitone	fitbitblaze	fitbitones	fitbitzips
alta			
Heart rate monitor terms			
heartratemonitor		heartratemonitors	

*The term “eating” was omitted from this list as it occurred in the name of two of the included subreddits (i.e., *r/fuckeatingdisorders* and *r/EatingDisorders*).

**“heart” and “rate” were concatenated in corpus before “heartrate monitor”

Appendix E: Characteristics of the Study 4 sample

Variable	*Mean (standard deviation)*	*Median (minimum, maximum)*	*Number of sample*	*Percentage of sample*
Age (years)	28 (7)	27 (18,80)	-	-
Gender (current identity / assigned at birth)*				
Female/Female	-	-	2514	72%
Male/Male	-	-	844	24%
Different to assignment at birth/Female	-	-	100	3%
Different to assignment at birth/Male	-	-	15	<1%
Prefer not to answer	-	-	22	1%
Body mass index (kilogrammes/metres^2)**	24 (5)	23 (10,72)	-	-
Region of origin				
UK/Ireland	-	-	445	13%
Europe (non-UK)/Scandinavia/Russia	-	-	484	14%
USA/Canada	-	-	2277	65%
Middle East/Africa	-	-	26	1%
Australia/New Zealand	-	-	155	4%
Asia/Pacific (non-Australia/New Zealand)	-	-	57	2%
Mexico, Central/South America	-	-	47	1%
Prefer not to answer	-	-	4	<1%
Ethnicity				
White	-	-	2962	85%
White and Black Caribbean	-	-	18	1%
White and Black African	-	-	15	<1%
White and Asian	-	-	84	2%

Asian	-	-	184	5%
Black/Black Caribbean/Black African	-	-	34	1%
Arab	-	-	21	1%
Different ethnicity	-	-	155	4%
Prefer not to answer	-	-	22	1%
Employment status				
Employed (full-/part-time, self-employed)	-	-	2267	65%
Unemployed	-	-	225	6%
Full-time student	-	-	884	24%
Retired	-	-	13	<1%
Different employment status	-	-	83	2%
Prefer not to answer	-	-	23	1%
Physical activity (days per week including at least 10 minutes of specific activity)				
Walking	5 (2)	6 (0,7)	-	-
Moderate activity	3 (2)	2 (0,7)	-	-
Vigorous activity	3 (2)	3 (0,7)	-	-
Compulsive Exercise Test: Total score	12.98 (2.72)	12.92 (1.84, 23.42)	-	-
Avoidance and rule-driven behaviour	1.95 (.99)	1.88 (0,5)	-	-
Weight-control exercise	2.83 (1.11)	2.8 (0,5)	-	-
Mood improvement	3.51 (1.02)	3.6 (0,5)	-	-
Lack of exercise enjoyment	1.65 (1.09)	1.33 (0,5)	-	-
Exercise rigidity	3.04 (1.09)	3 (0,5)	-	-
Sporting history				
No, never	-	-	1690	48%
Yes, previously	-	-	1265	36%
Yes, currently	-	-	504	14%

Prefer not to answer	-	-	36	1%
Eating Disorder Examination Questionnaire: Global score	2.01 (1.36)	1.73 (0,6)	-	-
Restraint	2.46 (1.52)	2.4 (0,6)	-	-
Eating concern	1.11 (1.36)	.4 (0,6)	-	-
Shape concern	2.36 (1.71)	2 (0,6)	-	-
Weight concern	2.13 (1.62)	1.8 (0,6)	-	-
Eating disorder history				
No, never	-	-	3091	88%
Yes, previously	-	-	289	8%
Yes, currently	-	-	93	3%
Prefer not to answer	-	-	22	1%
Specific eating disorder history***				
Anorexia Nervosa	-	-	146	38%
Bulimia Nervosa	-	-	68	18%
Binge Eating Disorder	-	-	46	12%
Eating Disorder Not Otherwise Specified	-	-	110	29%
Other	-	-	8	2%
Prefer not to answer	-	-	4	1%
Body checking				
Body Checking Questionnaire: Total	47.47 (18.43)	42 (23,115)	-	-
Male Specific Body Checking Questionnaire: Total	35.62 (13.23)	33 (19,95)	-	-
Length of response to sentence-completion question (words)	16 (20)	11 (1,346)	-	-

Note. Mean and median provided for continuous variables, number and percentage of sample for categorical variables.

*Gender categories correspond to current gender identity followed by sex assigned at birth. ‘Prefer not to answer’ includes any respondents who indicated this option for one or both of the gender questions.

** One case excluded due to ‘Prefer not to answer’ response being selected.

***Values calculated for sample of 382 participants who indicated previous or current eating disorder history.

Appendix F: Eating disorder subreddit search terms

Eating disorder (general)	*Specific eating disorder diagnostic categories*	*Eating disorder-related online content*
eating disorder	anorexia	thinspiration
eating disorders eating	anorexic	thinspo
disordered	anorexics	bonespiration
eatingdisorder	proanorexia	bonespo
eatingdisorders	pro-anorexia	
eatingdisordered	ana	
disordered eating	proana	
disorderedeating	pro-ana	
ed	bulimia	
eds	bulimic	
proed	bulimics	
proeds	probulimia	
pro-ed	pro-bulimia	
pro-eds	mia	
	promia	
	pro-mia	
	binge eating	
	pica	
	rumination disorder	
	ednos	
	food intake disorder	
	arfid	
	osfed	
	ufed	

Appendix G: Eating disorder subreddits

Eating disorder subreddit names		
r/AnorexiaNervosa	*r/eatingdisorderstories*	*r/ProAnorexia*
r/anorexic	*r/EDFood*	*r/ProBulimia*
r/antiana	*r/Ednos*	*r/proED*
r/ARFID	*r/edpics*	*r/proEDadults*
r/AustinEDs	*r/EDRecovery_public*	*r/ProEDmemes*
r/bingeeating	*r/edsupport*	*r/ProMia*
r/BingeEatingDisorder	*r/EncourageEating*	*r/proThinspo*
r/Bingeeatsupport	*r/fuckeatingdisorders*	*r/selectiveeating*
r/BingeSupport	*r/malethinspo*	*r/SFBayEDs*
r/bulimia	*r/MyProAna*	*r/ShittyProAna*
r/BulimiaRecovery	*r/NoBinge*	*r/StopPurging*
r/disorderedeating	*r/nobingeing*	*r/thinspo*
r/EastBayEDs	*r/nothaes*	*r/thinspocommunity*
r/eating_disorders	*r/overcomebingeeating*	*r/Thinsporation*
r/eatingdisordered	*r/ProAnaMia*	*r/truespo*
r/EatingDisorderHope	*r/ProAnaMPA*	*r/TrueThinspo*
r/EatingDisorders	*r/proanaweightloss*	

Appendix H: Physical activity self-monitoring search terms

List 1 search terms (*n*=33)				
accupedo	heal be	mapmy	orange theory	strava
apple health	healbe	mi band	orangetheory	wahoo
cronometer	i health	miband	pacer	withings
fitbit	jawbone	misfit	pedomet	ze fit
fitness budd	lifesum	mynetdiary	pokemon go	zombies run
forerunner	livestrong	noom	pump up	
garmin	map my	nsuns	runkeeper	

List 2A search terms (*n*=66)		*List 2B search terms* (*n*=68)	
accumulat	looking up	activ	pilates
add up	map	aerial	pole
adding up	measur	aerobic	pull up
adds up	memori	ballet	repetition
analy	memory	barre	reps
approximat	mentally	basketball	ride
ask myself	monitor	bench	riding
asking myself	note	bike	rowing
assess	notic	biking	run
attent	noting	boulder	sedentary
aware	photo	boxing	sets
calculat	post on	burn	sit up
check	posted on	burpee	sitting
clock	posting on	cardio	soccer
conscious	posts on	chore	spinning
count	quantif	climb	split
detect	recall	cycling	sport
document	record	danc	sprint
enter	remember	elliptical	squat
estimat	remind	exercis	stair
eyeball	research	expend	standing
filling in	screenshot	fidget	step
gaug	summar	football	swim
googl	sync	gym	tdee
input	tabs	hike	training
jot	timing	hiking	treadmill
journal	track	hockey	walk
keep an eye	updat	jog	warmup
keeping an eye	upload	jump	work out
label	view	lifting	worked out
list	watch	martial	working out
log	writ	move	workout
look up		moving	yoga
looked up		output	zumba